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PREFACE.

It has been the custom of late years for the Lecture Sub-Committee of the Manchester and Salford Sanitary Association to draw up a scheme of subjects for the Winter course of Health Lectures, and whilst giving entire freedom of treatment to each lecturer, they have endeavoured to preserve some sort of unity amongst them. Thus each volume of late years has been not merely a collection of detached essays upon any subjects in which the lecturers took a special interest, but, owing to the guidance of the sub-committee, it has become a small treatise upon some department of sanitary work—such, for instance, as "Preventible Diseases and the Means for their Prevention" (Series 1880-81); or, "The Arrangements relating to Houses and their Occupants" (Series 1881-82). It appeared to the committee this session that the time had arrived when an attempt should be made to give, in plain simple language, some instruction as to the natural laws that underlie all true sanitary teaching; in other words, to have a course of lectures upon what might be called "Sanitary Biology." Biology is indeed the science of the laws of healthy life, and a knowledge of these laws at once places a man in a position to judge as to whether certain conditions are or are not favourable to health. Even without special sanitary teaching he can often decide as to the healthiness or otherwise of a certain mode of life, and whether it transgresses in any particular the limits that have been imposed upon us by the Creator. The laws of nature, equally with the moral law, emanate from the same law-giver, and disobedience to them is followed by even more certain punishment in this world. It would, however, greatly assist such a student of nature if the bearing of these laws upon every day's necessity could be pointed out. Following out, therefore, their aim of diminishing sickness and suffering, and of preventing premature death, the Committee of the Sanitary Association have thought it desirable this year to treat especially of the science of healthy life. A glance at the syllabus of subjects selected for the present course will show that each of the chief actions of life receives attention from one or another of the lecturers; and, although no attempt will be made to give a complete course of biological study, special attention will be given to those points that bear most directly upon the healthful conduct of life, and thus indirectly a powerful argument will be framed in favour of those sanitary precepts that have formed the subject of previous health lectures. May we not hope further that another result of this study of the human frame will be to lead men's thoughts to higher things? Of all created things none are more likely to do this than the human body, and we may apply to it Spenser's words, in his "Hymne in Honour of Beautie"—

> What time this worlde's great Work-master did cast,
> To make al things such as we now beholde,
> It seems that He before His eyes had placed
> A goodly Paterne, to whose perfect moulde
> He fashioned them, as comely as He coulde,
> That now so faire and seemly they appeare
> As nought may be amended anywhere.

ARTHUR RANSOME.

INDEX.

BREATHING.

By ARTHUR RANSOME, M.D., M.A.,

LECTURER ON PUBLIC HEALTH AT THE OWENS COLLEGE, MANCHESTER, AND EXAMINER IN PUBLIC HEALTH, VICTORIA UNIVERSITY.

THE subject assigned to me for this, the first lecture of the Health series this winter is that of "Breathing," and the physiology of this act would surely rightly come first if we were simply to consider the order of events of our life. The first conscious act of a living being is that of drawing a breath. Its importance might also entitle it to an early consideration, for when we cease to breathe we also cease to live—it is usually the last act of life. In works on Biology, however, you will generally find that the first subject treated of is that of the Blood, its properties, its preparation from food, and its circulation through the body. Respiration, or Breathing, is generally discussed towards the middle or end of the treatise, as one of the means by which this blood is kept pure.

There is a good deal more of importance attaching to the process than this would imply, as I hope to prove to you before I have done; but still the order of subjects usually observed is a right one, and I cannot hope to make you understand the act of breathing and its results without first dealing with the blood, and without speaking, however briefly, of its circulation: the manufacture of blood from the food I may well leave to the lectures on eating and drinking; some of its uses will be mentioned to you under the head of working and resting; and some of the processes for its purification will be described to you in the lecture on washing; but I must give you a brief description of this vital fluid, and must say something of its course through the body.

Blood has been rightly called "liquid flesh;" or, as the French call it, "*la chair coulante.*" You will see from the following table that it contains precisely the same proportions as flesh of the four organic elements as they have been termed, namely, carbon, hydrogen, oxygen, and nitrogen. It also contains almost precisely the same

CONSTITUENTS OF	FLESH (BEEF)	OX-BLOOD.
Carbon	51·83	51·00
Hydrogen	7·57	7·17
Nitrogen..........................	15·01	15·07
Oxygen	21·37	21·39
Ashes	4·23	4·42

proportion of water. Although flesh is usually regarded as solid, and blood as liquid, they each contain about three-quarters of their weight of water. There was no need for Hamlet to say,

> "Oh, that this too, too solid flesh would melt,
> Thaw, and resolve itself into a dew,"

And blood is not all fluid; it appears so when it oozes from a needle prick in the finger, but if this drop of blood be placed between two pieces of glass, and if you try to look through it you will soon see how opaque it is.

Again, if you take a large quantity of this fluid and throw it upon a filter made of blotting paper, you will find that about one-seventh part of its weight will remain on the paper, and, moreover, if you wait awhile you will discover that a further portion of the blood, called fibrin, has become solid, and has formed what is called a "blood clot."

The clear fluid left behind when boiled also becomes solid, just in the same way as the white of egg becomes solid when it is boiled. It is indeed the self-same substance, and is technically called "albumen;" and lastly, if the whole portion of blood is burnt up in a furnace, a certain quantity of indestructible salt or ash will be left behind. Even then, however, we should not have exhausted its constituents, for if we had put the blood, as drawn from the body—under the receiver of an air pump—we could have drawn from it an appreciable quantity of certain gases—as much as half a pint from one pound of blood.

Perhaps the most interesting part of the blood is that which we have left upon the filter, and if we examine it with a

microscope we shall find that it is made up of myriads of little rounded but flattened discs, called "corpuscles," or the "little bodies" of the blood. Most of these are red in colour, but a few, in the proportion of one per cent, are white. They are so small that of the white ones 2,500 placed side by side would only extend to the length of an inch, and 3,000 of the red bodies would stretch to the same distance. It has been reckoned that there are from three to five millions of these bodies in every drop of blood, and they are so important that when this proportion sinks to any extent the body loses health and vigour, and becomes pale and weak.

They owe their colour to a peculiar red dye containing a large proportion of iron, a substance called hæmoglobin—and it was formerly supposed that the red corpuscles were cells, tiny closed bags of fine membrane containing the fluid hæmoglobin.

It is more probable now that they are little masses of living jelly—shaped as I have said, and possessing the power of absorbing the gases of the blood—much as a sponge will take up water, or rather in the same way as spongy platinum or animal charcoal will take up gas. These bodies are the chief agents in the act of breathing.

Such briefly is the constitution of the blood, and this marvellous fluid is sent from the great central forcing pump, the left heart, to all parts of the body. By means of a most beautiful mechanism of valves, this organ, which is simply a muscular bag, is able to force through the tubes that branch from it, about three ounces of blood at every beat, and as it beats 60 to 80 times in one minute, it is able in that time to cause from 15 to 20 lbs. of blood to circulate through the body.

It has been calculated that the total amount of blood in the system is about this quantity—viz., 15 to 20 pounds, so that in one minute it is possible for the whole of the blood in the body to pass through the heart, and, therefore, throughout the system. The rate of movement of the blood is, however, very unequal. The aorta, the great artery through which the blood leaves the heart, soon gives off branches, and these divide and sub-divide like the branching of a tree, ending at last in tiny little twigs called "arterioles," and these lead finally into a meshwork of vessels called "capillaries"—hair-like tubes, so small that the red corpuscles of the blood can only just pass through them—in other words, only $\frac{1}{3000}$ of an inch in diameter. They are so closely

packed together that, as you all know well, a needle prick will draw blood from almost any part of the body.

At each subdivision of the arteries, the area through which the blood passes is slightly increased, until at last, in the capillaries, it has been estimated that this area is 400 times greater than that of the great trunk vessel, the aorta.

The consequence of this is that, just as a mountain stream rushes swiftly through a confined channel, but flows sluggishly along when it broadens out into a pool, so it is with the blood, and in the fine meshwork of vessels in the tissues, it only moves at the rate of about one inch in a minute.

It also acquires a steady, continuous motion, partly from the above-mentioned cause, and partly owing to the elasticity of the arterial walls. The jerking motion of the blood, due to the successive jets forced from the heart, is gradually toned down by the alternate yielding and contraction of the arteries. It is felt in the wrist, for instance, as the pulse, but when it reaches the finer twigs of the arteries it is lost, and in the capillaries it is so even and slow as to allow of the interchange of commodities between the tissues and the blood.

But what is the work carried on by the blood and by its floating corpuscles? Let me read to you the answer to this question, given by the late Professor Wilson, of Edinburgh; he says, in his essay on "Chemical Final Causes" (Edinburgh Essays):—"Those wondrous crimson barks or blood cells which navigate the arteries are keen traders, and follow the rule of the African rivers where sales are only effected by barter; but they add to this rule one peculiar to themselves, which neither civilised nor savage man cares to follow, namely, that they give away new goods in exchange for old. Here the traffickers on the red river deposit fresh brain particles to replace those which the immaterial spirit has sacrificed to the expression of its thoughts; for Jeremy Taylor taught a great physical truth when he declared long ago that 'whilst we think a thought we die.' The eloquent preacher saw death near us at every moment, and nearer at each than the moment before; but death is in us at every moment, and it is not merely *whilst* but *because* we think a thought we die. As fast as the blacksmith wastes his muscles by each blow the mariners on the river of life in his veins barter against the spent cordage of his arm, new flesh particles to make it strong as before; they restore to its integrity the exhausted auditory nerve of the musician, give

the painter a new retina, and the singer a new tongue. Wherever, in a word, the million lamps of life, which keep up its flame at every point of the body, have burned to the socket they are replaced by freshly-trimmed ones. Nor is it here as with the barter of Aladdin's Lamp; the new lamp is in this case the magic one, the genie has departed from the old."

But the blood has to do something more than this.

We might perhaps conceive the idea, that growth of the body is accomplished by the living tissues taking nourishment from the blood and building it up into the body, as bees add cell to cell in the honeycomb. But even the bees need something more than pollen to enable them to do this, and then there is other work to be done in the body. What shall we say respecting movement and warmth—how are these brought about?

A little consideration will show that food alone will not produce either heat or motion.

Take the parallel case of a steam-engine, with its furnace and boiler. What makes it work, and how is it heated? It is said that when the late George Stephenson, the great engineer, was once asked what it was that was causing a locomotive to rush along on its iron road he replied, "the light and heat of the sun," and he was right. Millions of ages before, the light and warmth of the sun had enabled the great forests of tree ferns and club mosses to take up carbon and hydrogen from the air and build them into their frames. In course of time these had fallen to the ground and had been overwhelmed by floods, and had gradually changed into the substance that we call coal, and this coal, when put into the furnace of the steam-engine, had again brought forth heat and energy, and had urged the locomotive along. But what had set free this force from the dull inert mass of coal? Think again and you will see.

If you place the coal in the furnace it will not burn of itself. You have to set it alight; bnt if you shut out the air from it, if you close up the chimney and shut the furnace doors and stop up the draught, you will get no flame, and no force from the coal—the engine will not work. There must be something in the air then that starts the action, and that something is oxygen gas, of which there are two parts in every ten of air. Oxygen is the great liberator of energy from coal. Place a little ignited charcoal in a jar of oxygen and you will soon see how it will burn. *(Experiment.)* The particles of oxygen fasten with eagerness upon the charcoal

and change it into a compound called carbonic acid gas, such as appears in smoke, and in the process light and heat are given forth again, and by the mechanism of men's artifice they are transformed into motive energy. That carbonic acid gas is produced is easily shown by pouring the heavy gas into lime water, insoluble carbonate of lime being thrown down as a white cloud. *(Experiment.)* Something very similar to what we have seen taking place in the furnace of a steam engine is constantly going on in the body. Fuel in the shape of food is carried by the blood to every little cell in the body, and along with it, carried by the red corpuscles, travels a portion of life-giving, energy-liberating oxygen. A kind of slow combustion goes on continually in every part of the frame, and growth, secretion, mental activity, muscular movement, and all the manifold operations of life are the results. The final products of this combustion are also the same as in the case of burning fuel; water and carbonic acid are given off, along with some other imperfectly burned out products.

The water may be seen in every breath that we give out on a clear frosty day, and the carbonic acid may be made manifest by breathing out through a tube into a beaker containing lime water. *(Experiment.)*

And now at length we reach our proper subject—"Breathing." The means by which the oxygen of the outer air gets to the blood, and by which carbonic acid is removed from it, constitutes what we call the action of breathing.

What are these means?

The blood that has been circulating through the meshwork of capillary vessels in the tissues is gradually gathered up by other vessels called veins. It has changed its colour, and from the bright red arterial tint, it has become of a duller and more purplish hue. The hæmoglobin of the red corpuscles has given up its oxygen and has taken up carbonic acid in its place, and refracts the light differently from what it did before.

The area of the veins now gradually contracts as the several branchings of these vessels unite together, and at last they are all formed into two great trunks, one coming from the head and upper parts of the body, the other from the liver and intestines and all parts of the lower regions and extremities of the body. Every drop of the blood is thus returned to the right side of the heart. Here it is kept quite distinct from the blood which we have seen poured out of the left side of this organ. There are in

truth two hearts placed side by side, and by means of a similar mechanism to that on the left, the impure blood is now forced to the lungs. At every beat of the heart an equal quantity of blood to that sent to the body is now sent on to the lungs, and is not allowed to return to the general current of the body until it has got rid of its carbonic acid and has taken up a fresh supply of oxygen from the air.

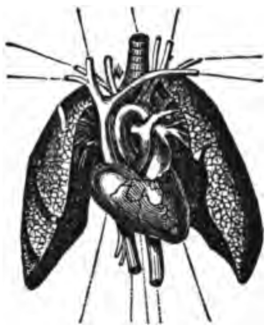


Fig. 1. HEART AND LUNGS.

The lungs (Fig. 1) are two great organs that look and feel something like masses of sponge, and are contained within the cavity of the chest, on each side of the heart. Their structure will be best understood by following down the windpipe from the nose and mouth, through which the air enters. This tube, which is composed of membranous and muscular structures, kept open by rings of gristle, divides behind the heart into two branches called bronchial tubes, one to each lung. As soon as each of these enters the organ to which it belongs it divides and sub-divides into a number of smaller tubes, again like the branching of a tree, until at last tiny twig-like tubes are reached, formed of a fine membrane no thicker than a film less than $\frac{1}{5000}$th of an inch in thickness, and out of these open the little pouches called air-sacs, upon which are spread innumerable blood-vessels. This membrane of which the air cells are composed is necessarily so fine in order that the outer air may readily pass to the blood. It is, indeed, scarcely thicker than the film of a soap-bubble, and under the microscope it looks almost as frail and delicate. It is an appalling thought that this soap-bubble film is all that stands between us and death; all that prevents the blood from pouring out through our mouths.

I remember that one of the first sanitary lectures I ever delivered was one "On the Fearful and Wonderful in the Body of Man," taking the words in their simplest and most evident sense, and showing first the reasonable fears that might be entertained on account of its structure and the work it had to perform, and then the wonderful manner in which danger had been provided against.

One of the illustrations was this of the structure of the lungs, and truly the danger at first sight seems real enough, when we consider that we are separated from death by a film of membrane of $\frac{1}{5000}$th of an inch in thickness. And yet, how wonderfully is the danger provided against—how seldom do we hear of fatal coughing up of blood, except in cases of disease.

Time would fail me if I were to attempt to mention all the precautions that are taken to ward off this danger. In the first place, the texture of the lungs themselves is elastic in the highest degree; throughout it is woven out of tough yellow elastic tissue—disposed so as to give lightness with the greatest possible strength. Next, the lungs are hung suspended in the cavity of the chest, bearing their weight entirely upon the elastic windpipe, and upon the great vessels coming from the heart, and thus any jar or shake to the body is transmitted through the successive branchings of the bronchial tubes down to their finest twigs, and thus the final air sacs rest upon springs more delicate and lighter than even those of the fabulous chariot of the fairy queen.

Again, observe how the lungs are inflated—how these tiny bellows are blown—and the air drawn into them in the act of breathing. If the bony walls of the chest had been fastened to the delicate textures of the lungs these last would soon give way and be torn to pieces by the strain; but it is so contrived, that there shall be no connection between either the ribs or the floor of the chest and the lungs themselves.

The lungs hang quite loose in the cavity, but they are surrounded by a membrane called the pleura, which is turned back over the inside of the ribs and over the diaphragm closing the chest below. This membrane forms a closed sac, with only a little moisture lubricating its sides where they touch, and when the ribs are drawn up, and the muscular floor is drawn down, so as to increase the size of the cavity, it affects only this closed bag of membrane, tending to draw its sides asunder; but, unable to do so, it causes a vacuum in the pleural cavity, and then the ordinary atmospheric pressure of the outer air presses gently down the

windpipe and expands the lungs equally in every direction, without the least strain or unevenness in any part.

This action is easily shown by suspending an india-rubber balloon by a tube inside a bell-glass, the base of which is filled up by a diaphragm of bladder or india-rubber. When the diaphragm is pulled down it will be seen at once that the balloon becomes inflated. *(Experiment.)*

Another precaution is also taken, lest in the course of this inflation any of the bloodvessels should be torn across. If the inflation took place so as unduly to stretch these vessels, they might easily give way, but they are disposed in such a tortuous zig-zag fashion that the filling of the air sacs only slightly straightens their course; they are never subjected to any pull in the line of their track.

Lastly, the danger of admitting cold air to the tender lining membrane of the air cells is also guarded against. Not only, as we have seen, is this air admitted most gently, and its entrance regulated by the muscular walls of the air-tubes, but before it reaches the cells it is thoroughly warmed—first in the mouth and larger tubes, and afterwards by mixing it with a large proportion of air called "residual air," that is always present in the lungs.

It is impossible to expel, with the strongest effort, more than half the air in the chest—the rest remains to warm the fresh air entering by the windpipe, and in ordinary breathing not more than one-tenth part of the air is changed at a time.

I might also tell you of the contrivances that are used to expel foreign particles that pass in along with the air, but some of these are mentioned in the published health lecture on "Foul Air and Lung Disease," and enough has probably been said to make us join in the thought of the sacred poet—

> "Fearful and wondrous is the skill which moulds
> Our body's vital plan."

The work that is accomplished by this marvellous apparatus is simply that which we have already seen to be necessary to the body—namely, the entrance of oxygen to the blood, and the extraction from it of the carbonic acid, or the smoke, coming from the combustion of the fuel of the food. Air, as it enters the mouth or nose, contains only four parts in 10,000 of carbonic acid, and when it again leaves the lungs, in expiration, it contains about 500 parts per 10,000, and a quantity of aqueous vapour, with some

organic matter suspended in it. We have already made this gas visible by breathing into lime water; it only remains to say that as much as 8oz. of solid carbon are thus passed away out of the body of an adult man in the course of 24 hours.

The oxygen in the entering air is in the proportion of 20 per cent, and in the air as it is breathed out again this is reduced to only 16 per cent, and it can easily be shown that in this state, owing to the deficiency of oxygen and the excess of carbonic acid, it will not support combustion *(Experiment)*, and I may add it will still less support life, for it now has actively poisonous properties.

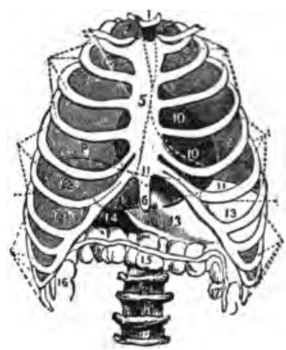
The sanitary lessons that may be drawn from even this outline of the physiology of breathing are very numerous, but I shall only have time to mention a few of the most important ones.

5. Breastbone.

8. Right Lung.

9. Left Lung.

10. Heart.



12. Stomach.

13. Liver.

15. Bowels.

Fig. 2. THE CHEST.

First, as to the mechanism of breathing. You have seen the sort of cage of long slender bones in which the lungs are contained, and I hope you will have realised how important it is that the action of these several levers, in enlarging and lessening the space, should be as free as possible. But, I must further point out that in the living state these bones are comparatively soft and yielding, and that they will give way under constant pressure, especially in young people. Hence the continual warfare waged by medical men against stays, or lacing or bonds around the chest of any kind. Moreover, during childhood it is not uncommon for these bones to get distorted, owing to complaints accompanied by difficulties of breathing, such as asthma or bronchitis, croup or whooping

cough; or, again, owing to bad habits of stooping over their lessons.

The chest then becomes contracted or pigeon-breasted, and the lungs have not free play. It is very desirable, if this should occur, that it should be rectified as soon as possible, and this is best done by appropriate exercises of such a kind as to make the muscles pull the bones into their right shape again. It cannot be done by mechanical means, such as chest expanders or straps of any kind; rowi g movements, or club exercises, or games in which both arms are used, are the best means for accomplishing our end.

2. The second lesson we have to learn is as to the quantity of air required by each one of us in order to keep us in health.

In the course of 24 hours about 2,000 gallons of air pass through our lungs; and we have seen that the air thus expelled from them is unfit to support life—nay, even that it is highly poisonous. It not only contains carbonic acid gas, but some other organic matters that are much more deleterious. It has been ascertained by direct e periment that air containing respiratory impurity, measured by an addition of only two parts of carbonic acid per 10,000 of air, is the limit of such impurity that can be allowed to be present if we are to remain in health. But in order to attain this standard, no less than 3,000 cubic feet, or 10,000 gallons of air per hour must be available, and well mixed with the air breathed. In other words, by our breathing we spoil 120 times more of air t an we can use in our lungs, and instead of only 2,000 gallons, we need 240,000 gallons of air every day of our lives.

3. It follows from this fact that the air must be constantly renewed, and that when we are not in the open air, the rooms in which we live must have a constant flow of air both into and out of them, of at least 10,000 gallons per head, per hour, day and night. Thi is only to be obtained by efficient ventilation; and in order to sweep away the organic impurity there must be currents of air alwa s flowing gently in and out. How to obtain this without draughts is the difficult problem of ventilation, and to answer it I must again refer you to several of the health lectures of past years.

4. After all that has been said, do I need to insist any more upon the necessity of purity in the air breathed? Can we, without grave peril, expose the delicate structures of the lungs, or the streams of our life-blood passing through them, to air that is in any way charged with impurity? The experience of our manufac-

turing towns would afford a sufficient answer to the question if any were needed after our examination of the anatomy of the lungs.

The influence of air charged with smoke or irritating vapours or dusts of various kinds, coming from our manufactories in Manchester, is shown by the excessive number of deaths from diseases of the respiratory organs in this district. Three times as many deaths from this cause are registered in Manchester and Salford as compared with healthy districts in other parts of England.

5. Lastly, with such a quantity as 2,000 gallons of atmospheric air passing through our lungs per day, it is not to be wondered at that if the germs of fevers or other diseases are present they may readily be conveyed by this medium, and I must especially warn you against contracting the deadly seeds of that scourge of our race—consumption, a disease that has been abundantly proved to arise from crowded, ill-ventilated, and badly drained living rooms, and from congregations of people imperfectly supplied with previously unbreathed air.

WASHING AND BATHING.

By H. G. BROOKE, B.A., M.B., Lond.

IT might seem an unnecessary task for me to address on the subject of cleanliness an audience who have so much regard for their personal health as to come and hear a health lecture; for it is impossible to suppose that those who are here were in any way doubtful as to the relative merits of cleanliness as against dirtiness, and had come to see what I had to say in its favour. It is not, however, a superfluous task, but, on the contrary, a very necessary one; for I am not here to speak to the clean, but rather through them to those who are not clean, and I hope that I may perhaps, by what I have to say, induce some of you to assist by your personal influence in coping with this great evil of personal dirtiness which lies so openly at our very doors.

Medical men have exceptional opportunities of observing not only the effects of uncleanliness, but also the incredible extent to which it prevails. They find those who are taken unawares and brought into hospital to be almost always very unclean, and those who are called upon suddenly to expose themselves for examination are generally very dirty, sometimes repulsively so. And what, moreover, is a very hopeless sign is the ignorance which the dirty have of their dirt, the apathy with which they regard it, and the unbelief with which they often receive the announcement of its existence. It is not unfrequent for patients, who are so downright dirty as to make any contact with them exceedingly disagreeable for their medical attendant, to feel aggrieved and even insulted when their condition is pointed out to them.

But it needs no medical man to find out all this dirtiness, if you have not guessed at its extent, you at least know of its existence. How many of those whom we meet in the street look really clean and wholesome—and how many smell clean and wholesome

The dirty clothes only too clearly betoken the dirty skin beneath and the whole is pervaded with that mawky sickly smell which is so familiar in the dwellings of the poor, and which finds its origin in the long lying decomposing dirt with which their bodies are covered and their bodily belongings impregnated.

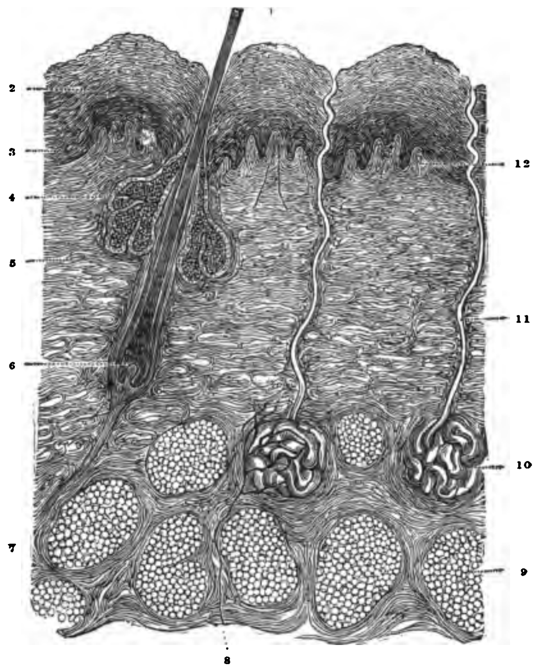
We know that there are thousands of those around us who never wash their bodies from year's end to year's end. I have heard authentically from prison authorities that to some elderly prisoners the bath has come as a perfectly new experience and a very objectionable one. We hear from workhouses of the same unwillingness to bathe on the part of the inmates, and of paupers willing rather to forego their holiday than to submit to the regulation bath on re-entering.

Man is essentially a creature of habit, and the habit of uncleanliness seems to cling as closely to him as its parent—the habit of idleness. But it is a curious thing that although so many animals exercise the greatest care and attention in freeing themselves from dirt, man, by far the highest of them all, should be, in this respect, so negligent. But so it is, the savage, the natural man, untramelled by the restraints of civilisation, is a dirty animal. Only accidentally is he kept clean by casual fishing or swimming, or by exposure to rain. We English, moreover, seem to have gained an unenviable notoriety for our dirty habits long enough ago, and Erasmus, the celebrated theologian of the fifteenth century, draws but a very uncomplimentary, although unquestionably true, picture of the habits and manners of our forefathers. Four more centuries of civilisation do not seem to have helped us much in this respect, and we should not have to go far from this spot to find conditions almost as bad as those which he describes.

The visitation of the poor reveals a widespread state of uncleanliness of which many of you have but little idea; not only are their houses unbearably dirty and foul-smelling, but their bodies are in a like condition, and more or less commonly infested with vermin. The visiting medical officers of the Royal Infirmary find that at least two out of three are beset with lice, while fleas and bugs are very frequent guests. To such an extent is this the accepted state of affairs, that many seem astonished when spoken to about them; and one woman recently, whom I reprimanded for coming to the hospital with lice on her head and clothing was much offended. She was, she said, with a fine show of virtuous indignation, as clean as any woman in Manchester; she never

had more than three or four lice on her at one time—"as who hadn't?"

Well, you may ask, since all these people are so dirty and live on often to old age in spite of their dirt, is cleanliness



SECTION OF SKIN.

1 Shaft of fine hair.
2. Horny layer of scarf skin.
3. Soft part of scarf skin.
4. Oil gland.
5. Corium, or true skin.
6. Root of hair.
7. Layer of fat.
8. Blood-vessel to sweat gland.
9. Layer of fat under the true skin.
10. Sweat gland.
11. Canal of sweat gland.
12. Papillæ of true skin.

necessary to health? That depends uopn what you call health In my opinion the care of health consists not only in keeping the body free from those conditions which endanger life, but quite as

much in keeping it in such a condition that its owner can enjoy life perfectly, in so far as the body is concerned in producing happiness. It is not absolutely necessary to life to cleanse the teeth; but the dentist will tell you who has the more comfortable time—the man who attends to his teeth with brush, powder, and quill, or the man who neglects them.

But let us examine this dirt, and see what it is and where it comes from, and we will afterwards look a little more closely into its action on the skin. And in the first place I must, for the sake of those of you who know nothing about it, give you a slight sketch of the formation of the skin.

SURFACE OF SKIN MAGNIFIED, SHOWING MOUTHS OF SWEAT GLANDS.

Here I have a diagram of a section through the skin, which shows you its structure just as you see the structure of the earth's skin when looking at the steep sides of a quarry or a railway cutting. You will see at once that the skin is not a simple leather-like covering for the body, fitting it as a glove does the hand and drawing off like a glove or stocking, although the ease with which animals are flayed might lead you to think so. It is, on the contrary, a complicated organ, an organ with many duties. It is, as you see, composed of these little round bodies called *cells*, and of this fine stringy substance, *the connective tissue*, which we find like a strong spider's web between the different parts of the body in any dead animal when being prepared for cooking. This fibrous tissue acts like a scaffold to support the glands, blood vessels, and nerves of the skin. The round cells* in this upper layer are softer below, but keep growing harder and more horny as they are pushed upwards

* Not shown in this diagram.

by those which grow beneath them, until they are finally rubbed off from the outer surface, as the little horny scales which we find like white dust inside our stockings and underclothes. These transparent round cells in the lower layer are the fat cells. The bunches of fat cells in the skin not only help to keep the body warm, but they also serve as padding to fill up holes and corners, and thus make the surface of the body smooth and even.

Now look at these bodies lying deep in the fibrous tissue and always in connection with the fat cells, each formed of a long tube curled up like a ball of worsted, and ending in a long discharge pipe, which opens on to the outer surface. These are the *sweat glands*, and the cells which line the tubes are little chemical works in which the largest part of the sweat and a portion of the oil matter which anoints the skin are manufactured from the blood. Largely by means of its sweat glands the skin relieves the kidneys, when these bodies are overworked or on the sick list, both organs removing excess of water and waste matters from the blood; and to such an extent does this double action prevail that if the skin is painted over with a waterproof varnish the kidneys take upon themselves the whole of its work, and so completely, that beyond a feeling of discomfort no harm arises. Whether they would do this permanently is not known, but fortunately for the dirty, their dirt is not impermeable like varnish, but always allows the sweat to work its way through; and this explains why uncleanliness is never by itself a direct cause of death.

The sweat, which is poured out in such quantities as sometimes to amount to several pounds in a day, is mainly composed of water; a small percentage of it consists of waste products from the blood, of fat, and of salts, and it is moreover always mixed with some acids produced by the decomposing fats. This mixture moistens the skin and soaks into the clothing, from whence the water and some of the acids later evaporate, leaving the solid and fatty matters stranded partly on the skin and partly on the clothes. It is familiar to everybody how greasy dirty clothing is.

The greater part of the grease, however, comes not from the coiled glands, but from these bunchy structures which are called *sebaceous glands*. These open directly on to the skin, or into the hair sacs, as shown in this diagram, and where they are well grown and in quantity as, *e.g.*, on the face, we can, on a warm day, often see the melted fat which they contain standing in drops at the gland mouths. Different people differ very much as to

the activity of these little fat glands. In some the fat is oil and runs freely, causing that greasy looking complexion which w sometimes see; in others the fat is more solid and tends to heap up as often takes place when the glands are very active, as in young people.

In all people the fat at the mouth of the gland tends to pick up dust and dirt from without and thus, where the glands are large, a on the nose and inside of the ear, their position is clearly marked b the little black dirty spot formed mainly by the mixture of fat an dirt. If this mixture is left to accumulate, this is what ofte happens. The dirt, mixing with the fat and hardening, forms plug which, as it were, corks up the mouth of the gland. Th gland keeps working on all the time, until, owing to the plugging it is finally swollen out with stagnant fat. In some parts of th body, this stagnation of fat forms a centre of irritation to the part around and inflammation is set up. Pus (or matter) forms, pushe its way up to the surface, and we then have that little painfu yellow-headed gathering known as a *pimple.* (*Diagram showin formation of pimple.*)

In cleanly people this plug is being continually removed by washing, and the passage from the gland being kept open, no harm results. But a disfiguring crop of pimples are often seen in those who are subjected to much dust in their employment, an do not take the necessary care to clear it away by washing whe their work is done.

But I would not have you suppose that this unsightly pimp condition is always the result of blameable dirtiness. The skin o some people is particularly liable to it, but inasmuch as th disease can be largely prevented by much and vigorous washing it furnishes a good example of the fact that some people requir very much more washing than others.

This skin grease may do harm, not only when in the glands but also when poured out upon the *surface* of the skin. Thus, i young babies, whose skin makes much such grease, it is ofte allowed to mix with dirt, and cake on, forming scales or patche which irritate the still very young and delicate skin, especially on th head, and as a frequent result of this we have that painful an unsightly condition, the so-called "milk crust," where the irritate skin pours out a sticky fluid which sets, forming these big dirt scabs. (*Picture of child affected with milk crust.*) If lice are a hand they soon get to work on such a head and burrow fre

n the raw flesh underneath the scabs. As this affection generally begins just about the age at which infants are legally vaccinated, it s very frequently put down by the mothers to the effect of the vaccine lymph. This, however, is a great error, as is proved by the fact that the disease frequently begins before the child is vaccinated. If mothers would only pay more attention to the cleanliness and nourishment of their children, they would find that they had one of their main objections to vaccination removed. Some mothers, it is true, do attempt to clean off these greasy scales from the head, but do it so roughly and with such irritating soap, as to set up a very similar condition to that caused by neglecting them.

The same affection is often seen amongst the poor as the result of the irritation set up by head lice, and anything more utterly loathsome than a well marked case of this disease can scarcely be imagined. Crust forms over crust, until the whole head is caked over with a thick layer of decomposing matter, concealing a raw and oozing surface beneath. Into this, under it and over it, the lice burrow and crawl, and the stench which exudes from this sickening mass is well nigh unbearable.

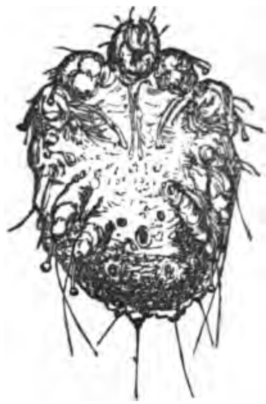
There are two other conditions found almost altogether among dirty children. One is a form of nettle-rash, which is common during teething, and causes the infant much distress and loss of sleep. The other begins as nettle-rash, but changes in the skin are being set up, it becomes chronic and may last for many years. The itching in this form is at times so intolerable, that all work or business pursuits are rendered impossible, and the sufferer must devote himself either to securing the temporary relief which the doctor can give, or to providing relief for himself with his finger-nails.

The delicate skin of infants must be cleansed with soap, flannel, and tepid water, thoroughly, but with great care. The deep folds and creases, as those of the thigh and neck, should always be most carefully wiped out, especially in fat children, since they are peculiarly liable to be inflamed by the action of the stagnant and decomposing sweat which they inclose, or by the irritating secretions of the bladder and bowels. But when scabs have once been formed the time for washing has gone by; soap and water is then injurious, and the case should be put into the hands of the doctor.

I will not take up your time by giving you a complete list of diseases which dirt may render man liable to, or which it may

complicate ; I must, however, just bring a few further samples c such to your notice.

It may be known to some of you that there are floating abou in the air numberless seeds of various exceedingly small an simple microscopic plants, which are only waiting for the oppo tunity afforded to them by a good ground to increase an multiply. Like the thistle-seed, they blow about until they fin a feeding place, and such a place they very readily find in th layer of fat and skin scales which cover a dirty skin. Ther is no doubt but that these small plants are intimately cor cerned in the going wrong of wounds, and the careful surgeo of these days is most particular to remove them before making



ITCH INSECT.

cut, by washing the skin with carbolic acid lotion or some othe antiseptic solution. It is highly probable that their presence i one of the reasons why trifling wounds so easily "fester" in dirt people.

But there are larger forms of vegetable parasites which also fin their home on the skins of dirty people. It is sufficient to giv you an example in one of the most common and well-marke cases.

This is a picture of a man (*Picture of a man affected wit Pityriasis versicolor*) who is, I think you will agree, somewha lax in his views of cleanliness—or at any rate in his manner o

arrying them out—and here you see these yellow brown patches which are caused by the slow growth of a microscopic plant on the surface skin, left to its extension undisturbed by the action of soap and water.

Other vegetable parasites flourish chiefly on the dirty, who form at the same time the prey of insect vermin.

Here you have a representation of a woman (*Picture of a woman affected with Phthiriasis*), by no means the worst of her kind, who has allowed the small beasts to live and move and have their being upon her skin, until she has been reduced to this deplorable condition. You observe the deep bloody finger-nail marks on the shoulders and loins, which show how she has ploughed into the skin in the hope of getting relief from the intolerable itching: here you see boil-like sores and gatherings caused by the irritation of the insect bites and the scratching in the befouled and unhealthy skin—there the sticky oozing, and scabs of like cause; and, scattered about, the purple-stained bites of the flea. And notice over all, this dirty muddy colour of skin, spotted here and there with these patches, of dark brown colour, which are a common result of the irritation caused by constant scratching.

After having now explained to you that the dirt on the skin is made up of the products of the skin glands, mixed up with dead skin scales and dirt from without, and having mentioned to you several of the diseased conditions which are produced when this dirt is allowed to lie on and irritate the skin, or to produce a breeding ground for parasites, I must now proceed to tell you how these things may be prevented—namely, as you all already know, by washing. But although you are all well enough acquainted with the practical details of the employment of soap, water, brush, and towel, it may be as well if I explain to you the actual nature of the process which goes on when soap and water are applied to the skin.

The soap which we use in washing consists, as some of you may know, of a chemical mixture of fat and alkali (potash or soda). I have in this flask a quantity of pure olive oil, and in this a solution of caustic potash in water. I mix the two and immediately you notice that a something quite different to either is formed; I boil it and a soap is produced. If I use potash, a soft soap is formed; if soda, a hard soap, the soap we commonly use. If I were to apply one of these alkalies directly to the skin much

the same proceeding would take place and a kind of soap would result. Now, if we wanted to make a piece of leather both bendable and waterproof, we should grease it, and as the surface skin must necessarily be bendable and to a very large degree waterproof, it is, as I have already pointed out, supplied with a natural grease by its oil and sweat glands. If, therefore, we use a soap containing too much alkali, this necessary grease is extracted from the skin, converted into soap, washed away, and the skin is left dry, wrinkled, and rough to the feel, as you may have noticed after using soft soap, which always contains too much free alkali.

All common hard soap also contains too much alkali, though perhaps not too much for a very greasy skin, and certainly not too much for washing greasy garments; still you see the unpleasant roughening and puckering effects, of which I just spoke, on the hands of washerwomen, which are necessarily exposed for a long time together to its action. It is not, however, necessary in ordinary skin-washing to have this excess of alkali in order to get the grease from the skin. For example, I have here a solution of soap, in which there is no such excess, and you will see that if I drop this piece of grease into it and shake up the flask the grease disappears, the ordinary white suds are produced, and if I now pour the water out, none of the grease remains sticking to the flask. It is, in fact, all broken up and suspended in the soap and water, like the little fat globules are suspended in milk, and is thus easily washed away by the water in which we rinse ourselves before using the towel. Such perfect soap is expensive, but ordinary soap will lose most of its alkali if kept, and we have thus an excellent reason, besides that of economy, for the old fashioned practice of cutting up and keeping soap for some time before using it.

As to the quack soaps and medicated soaps which are so much advertised, I can only advise you not to buy them. They are intended for the profit of the seller, not of the buyer. Glycerine soaps are pleasant to use and harmless; but the skin, if healthy, requires neither tarry preparations nor sulphur; and if it does require such medicines, it needs much larger quantities than those soaps contain.

As regards the water itself. It is always best to employ soft rain water, such as we have supplied to us in Manchester. Hard water, such as the London people are obliged to use contains lime, which irritates many skins, has an unpleasant feel, and wastes a tremendous quantity of soap.

Every one who is not daily washing away the accumulations of dirt and grease from his skin with sponge and water and brisk rubbing with the towel, should certainly make use of the warm bath at frequent intervals. Hot baths are relaxing, and unnecessary for ordinary cleansing purposes, but a warm bath melts up the fat on the skin, dissolves up other impurities which do not dissolve readily in cold water, and thus renders the cleansing action of the soap much more thorough. Warm baths, although unfortunately obtainable with difficulty in many homes, are now provided by the Corporation at a very low charge, and I cannot help but think that they would be much more freely used if they were only more numerous and more accessibly situated. It is surprising that they have not been made more extensively the object of private enterprise in this city, as they have with so much success in others.

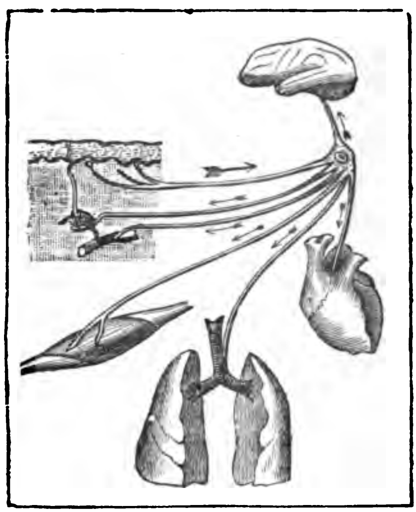
You have all heard of the unwisdom of putting new wine into old bottles, but it is far more unwise to put newly cleaned bodies into old dirty clothing. For foul clothing, having been soaked for days—or months—in the fat and waste given off from the skin, is not only dirty and bad smelling itself, but, of course, immediately befouls the clean skin to which it is applied, and brings back again just what the washing has removed. Frequent change of under-linen is, therefore, almost as important as frequent washing, and the practice—so universal among the working classes—of wearing the same pair of trousers for months together next to the skin, and without any under-linen to absorb the skin's secretions, is strongly to be condemned.

Washing and bathing are, of course, very intimately connected, but since washing is intended to cleanse the skin from filth, and bathing to make an impression on the skin and through it on the system generally, it will be necessary to consider them to some extent separately.

Since this effect of bathing is only to be understood by first understanding something of the blood supply of the skin, I will now explain this briefly to you. *(Diagram.)*

Each of these small arteries of the skin, which feed the skin and its glands with blood, and upon the proper working of which the skin is dependent, is composed of a very narrow tube, wrapping round and grasping which is a layer of little muscles. The blood inside tends to stretch the tube and make it wider, while the muscles always keep more or less grip on it and tend to make it narrower. These, like all other muscles, may be tightened

or slackened by the direct action of cold or heat upon them, but they are more specially governed by the nerves which are supplied to them. If any one were to take me unawares and throw a bucket of cold water over me, my muscles would tighten or contract, and I should jump, without first thinking why. If now I were to pour cold water on the skin, much the same thing would occur.



This set of nerves, which are supplied to the skin, telegraph up to the head office in the spinal cord that they feel colder, and a message is immediately sent down from this head office through this other set of nerves to the muscles surrounding the artery, to tell them to contract accordingly and make the artery smaller. Warmth, on the other hand, has a relaxing effect, and if the skin is warmed, the downward message would be to slacken the muscles, to make the artery larger, and let more blood in.

But not only are the arteries supplied with muscles, muscles run also obliquely through the skin and surround the sweat and sebaceous glands. These are acted upon by cold in a similar way. Thus, when they contract, the juices which the skin has done with

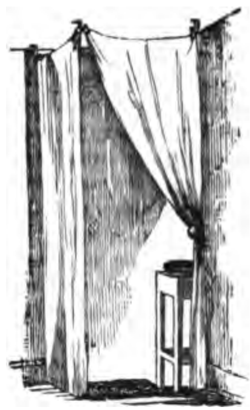
are squeezed into the return pipes and hurried away, the arteries are narrowed and the blood flow in them consequently quickened; the glands are relieved of the goods which they have already made, in fact, new life is infused into the business and old stock is got rid of. Now this so-called *tonic action* is best induced by bathing. Bathing is a tonic for the skin. But its action is not confined to the skin alone. The head office, which sends down messages to the muscles of the skin, sends also messages to the muscles of the trunk and limbs, to those of the heart, and those which work the lungs; the heart beat and the respiration are both quickened and enlarged, and the whole body thus roused up and freshened in its work.

The amount of shock which is just necessary to produce this effect differs very much in different people; but when once it has been found, the refreshing and invigorating influence of the morning bath is a luxury which once tried is most unwillingly foregone.

In no way is the effect of frequent washing and bathing more strikingly and openly shown than in the improvement of complexion and clearness of skin which it produces. I do not mean that by washing you can make a dark person fair, but many of the muddy blotchy complexions which we so commonly see could be rendered fresher, clearer, and much more wholesome-looking by the free use of the washing-bowl. For wherever blood stagnates the skin tends to become brown and dirty-looking, and it is by bringing into play the invigorating action of the bath on the blood vessels that this stagnation is prevented from taking place. I have often been struck by the contrast between the clear and ruddy face of the young soldier, who is compelled to keep himself clean, and the dirty unhealthy-looking faces of his former mates, with whom we see him promenading with all the air of superiority and condescension to which his clean face and his smart jacket entitle him. He, however, has other sanitary advantages in his favour, and if we wish to secure a clear tint of skin, we must take care that the effect of our bathing is not hampered and handicapped by errors in diet, (especially too much tea and too much liquor), by habitually breathing the impure air of ill-ventilated rooms, and by the irritating action of disordered stomach and bowels.

One great difficulty which immediately confronts us when we advocate the value and necessity of constant bathing is the want of ways and means in the criminally overcrowded houses which

"the great unwashed" inhabit. The rigour of our climate prevents us from washing in the open air, in yards and gardens, as the people do in Southern Europe, and the police would object to our adopting the procedure of the Japanese and bathing on the foot-path before our doors. Fortunately in some of the newer cottages baths are to be found, but in those in which they do not exist, a bathroom may easily be rigged up by stretching a sheet or curtain across one corner of a bedroom and using that as a screen. For



CONTRIVANCE FOR A BATH IN CORNER OF A COTTAGE ROOM.

those who cannot afford a flat bath, a large washmug of water will suffice, and a wet towel or a large piece of flannel will very well replace a sponge. The flannel or sponge, whichever it is, should be squeezed until the amount of cold water is not too great to give an unpleasant shock, and the body should afterwards be dried by active but not rough friction with the towel. Those who rise too early to allow of a morning bath before their work, should take one on returning home in the evening, and the bather is thereby, as I know, wonderfully refreshed from his day's toil.

I do not propose to speak to you of the employment of the so called *water cure* or *hydropathy*, for it belongs too exclusively to the sphere of the medical man. Although capable of doing good service when intelligently applied, it has unfortunately been brought into ill

repute by the reckless, ignorant and unconscientious manner in which it has been made use of by quack practitioners. The good which it produces is effected by the action of local or general changes of temperature, and by the calming or invigorating effect on the nerves of which I have spoken; and I should strongly advise none of you to allow any "water-curer" to produce an eruption on your skin, with the false and long-exploded object of "bringing out the disease." Such eruptions can be produced on the skin of healthy people by the same means as he employs, and it is ridiculous to suppose that any man can conjure the supposed essence of the disease into the small quantity of fluid which exudes from the eruption which he has produced.

One form of water cure, however, can be practised by all, and is all the more valuable to the general public as being a means of prevention rather than a means of cure. In a valuable lecture on "Colds," delivered in this series last year, Professor Dreschfeld explained that the first step in the production of a "cold" was the contraction of the arteries of the skin, owing to the excessive action of unaccustomed cold upon them, and the consequent driving of the blood into the inner organs. Now, just as with practice soldiers get used to the unexpected firing of guns without starting, so the muscles of our skin arteries may get used to the sudden and unexpected action of cold without this violent contraction and driving in of blood. Those who are in the habit of taking cold baths, soon find that they are far less liable to colds than other people; they have, in fact, become hardened, and accidental draughts and wettings have not the same powerful effect on them as on others who have not undergone the process. Many people, otherwise in sound health, coddle, and thus make themselves more tender, while that which they really need is the hardening process. Bathing the throat, for example, with cold water would do many tender-throated people far more good than the enervating practice of wearing a so-called "comforter."

But this hardening treatment must not be plunged into rashly and all at once; it must be undertaken by degrees. Beginning with tepid or warmish water, the temperature must be day by day slowly lowered down, until the lowest limit is discovered which the individual bather can bear with comfort and advantage. And this brings us to the subject of *over-bathing*. Just as with over-washing we can make the skin rough and set up painful and obstinate eruptions, or by too rough or too much rubbing bring a tender skin

into a state of inflammation, so can evil results arise from too much bathing, and bathing in water of too high or too low a temperature.

Nothing could be more rash than recommending cold bathing wholesale to all men. All bathing is at first a matter of experiment; each one must find out for himself how long, how often, and at what temperature he can bathe with most advantage. Some can lie down in ice cold water on a wintry day and seem none the worse for the shock; to others the shock of the cold water of summer is too great, and so low is the vital energy of a few delicate ones, that anything more severe than a tepid sponge is unendurable. Fortunately we have an easy test whereby to determine the temperature most suitable to our wants. If we feel a warm comfortable glow a few minutes after the bath, the experiment has succeeded and we can repeat it. The stimulus has just been sufficient; the heart has been spurred on, and the blood is coursing quickly through the vessels. Should the body on the other hand remain cold,and the skin instead of glowing be pale or blueish, the stimulus has been too severe, and the heart and vessels are paralyzed; the blood stagnates in the vessels, loses oxygen, and becomes blue, while the functions of the nerves are more or less suspended, and numbness and loss of power ensue. In such cases the body should be warmed artificially, and the skin briskly rubbed with towels to promote reaction, and assist mechanically the impeded circulation.

One of the most powerful means of cleansing and invigorating the skin is the Turkish bath. The heat melts out the accumulating products of the fat glands and by the forced and copious sweating which it induces, cleanses away the broken up cells and skin scales which clog the mouths of the glands. It is probable that the excessive dilatation of blood vessels which takes place may act beneficially, aided by the rubbing and slapping of the attendant, while finally the gradual lowering of the temperature of the water leaves the tissues well braced up. As in all other bathing, the same caution is necessary, and both the inner sweating chamber and the cold plunge are extremes not to be indulged in without previous experience of the bather's powers of endurance.

Finally one more form of bath, the sitz bath, in which the bather sits in a bowl of cold or tepid water for a few minutes. It is a vigorous general stimulant, especially for women, and possesses moreover the benefit of being taken quickly, and requiring no previous preparation.

Having attempted to explain to you, and advocate before you, the material advantages of cleanliness, I should now like to turn to its other and more important side, and to say a few words on its moral necessity.

The saying that cleanliness is next to godliness is trite, but contains much truth; still truer, I think, would be the observation that uncleanliness is the companion of crime and disorder. Look at the vast majority of those who fill our prisons and workhouses, are they recruited from the dirty or the clean? Those who fight and brawl in the streets, those who offend the passers-by with their coarse oaths and ribald jests, belong to the dirty and not to the clean. Nothing can be, I think, more clear and patent than the intimate connection between cleanliness of body and propriety of behaviour. But it is of no use attempting simply to frighten people into cleanliness by recounting to them a list of diseases to which their uncleanliness may bring them, nor the benefits in health and happiness which fall to the lot of those who take the trouble to keep clean. The Monday headache does not deter the tippler from his Sabbath orgies, nor is it the fear of prison which converts the criminal to a right course of life. It is no use to preach bare morals of any kind. Men do not act morally, simply because they know that they ought to act morally; nor from knowing, from a utilitarian point of view, that a moral line of conduct would bring them better results. No man, whatever his theory of morality, ever acts nobly and well unless he does so through pure love of what is good and noble. And it is so with cleanliness. You will never induce men to habits of cleanliness simply by dangling before them the fear of getting a skin eruption, or a dirty complexion, or of harbouring vermin. They will never be clean until either their pride is touched and they are shamed into cleanliness, or until they learn to appreciate the feeling of self-respect which cleanliness brings with it.

There are, I know, many practical difficulties in the way of this much to be wished for reform. The material obstacles which beset the path of modesty and decency among the dirty are the same which impede the growth of habits of cleanliness. We have to contend with overcrowded houses with entire want of accommodation and utter absence of privacy, with polluted rivers, and with a filthy smoke-clogged atmosphere, degrading and befouling men and homes alike, and almost crushing out all hope of our ever seeing a cleanly city and a cleanly people around us. In the crowded alley

and the hovel we find filth and indecency of every kind in closest companionship, and, if we want to attack the one, we must certainly pave the way by first repulsing and driving away the other. To bring a man into habits of cleanliness is one of the surest methods of creating in him that feeling of self-respect without which no moral conduct is possible. But so accustomed to this sordidness have many become, and so little do the mass of the working classes who live, year by year, everlastingly in its midst think that there is a brighter and purer aspect of everyday life within their reach, that we truly stand in need of a second gospel to preach this to them as a fact.

Important as is the feeling of self-respect in connection with cleanliness, there is the still higher and more powerful sentiment of respect to others which forms the basis of all social communion between man and man. But does the dirty man respect his neighbours? Does he give them their simple due, if he repels them by his very presence, and shocks them alike by his degraded appearance and by the odour which pervades him? Only those of us who have lived in better and purer surroundings know how such men are degraded by the dirt in which they live. Can we expect great and good and beautiful things to spring up in the midst of dirt, and can we expect any one to appreciate or even to see beauty if it be sullied by the presence of filth? And those who can appreciate no beauty can have no lofty and noble thoughts; to them this life is indeed a desolate and weary pilgrimage.

We should not love flowers if they were dirty and stinking, nor can we extend our hand in sympathy and fellow-feeling to a man who so coarsely offends all our finer sentiments. Indeed, it has always appeared to me that this personal uncleanliness is one of the great barriers to the existence of a really friendly feeling between different classes of society—for how is it possible that one who is scrupulously particular as to his cleanliness can have much brotherly sympathy and good feeling towards those whose face, clothes, and even the atmosphere about them proclaim to be negligent of what he regards as one of his primary duties to himself and to society? The dirty man is thus shut out from the society of those who are clean; he does not feel at home with them, and he is driven to associate with his like, as criminals are driven to live in a criminal world.

We must then regard uncleanliness as a degrading stamp of a man's want of respect to himself and to others, blunting his moral

sensibility and debarring him from the society of those whose intercourse would benefit and improve him.

The impediments to cleanly habits seem, as I before said, in many homes, almost insurmountable. I would ask you therefore to give your support, where and in what manner you can, to further the establishment of public baths and public wash-houses, which would fill up a very glaring gap, not only in the private convenience of the citizen, but also in the public sanitation of the city. And I would ask you, moreover, whenever the occasion presents itself to you, to use your influence or give your advice, kindly and unobtrusively, to point to those who are ignorant, firstly, what real cleanliness is, and then the moral and physical necessity of keeping clean. And in doing so you will be doing a good and much-needed work.

WORKING.

By HY. TOMKINS, B.Sc., M.D., &c.

THE subject upon which I have been requested to address you to-night is one of such large dimensions and has so many and varied phases that it is somewhat difficult to choose the exact manner in which to approach it.

There can be but little doubt that all who come into this world have some work to perform, either for themselves or for their fellows.

In the primeval curse man was told that "in the sweat of his face he should eat bread," and thus at first sight it might appear that work was a thing to be lamented, and, if possible, got rid of. But everyday experience teaches that there is not a more miserable and discontented being than the man who has nothing to do, or can find no fitting occupation to engage the attention of his mind or body. To the greater number of us work comes as a stern necessity, but not on this account need it be regarded as a misfortune.

When we talk of work we may mean one of many kinds of work, mental work, intellectual work, skilled labour, or hard manual physical labour, and it is chiefly to this latter kind of work, viz., to manual labour, that I would direct your attention for a short time this evening.

By manual labour we understand the exercise and use of our muscular system. All muscular work is the result of contraction of our muscles, and further, almost every movement in the body is the result also of muscular contraction; whether we walk or talk, or breathe, or eat, or in fact move any part of our body, these movements are produced by means of our muscles, and, therefore, I propose, first, to speak to you a little concerning these muscles, which, as you must easily see, play so important a part in our life and being.

The greater part of our bodily frame is made up of a number of bones, to which are attached numerous muscles by which these bones are moved, and which give bulk and rotundity to the skeleton, whilst outside all is the skin to protect and keep them warm and compact, something like the paper outside a parcel in which are wrapped numerous articles, all kept by it firmly and securely together.

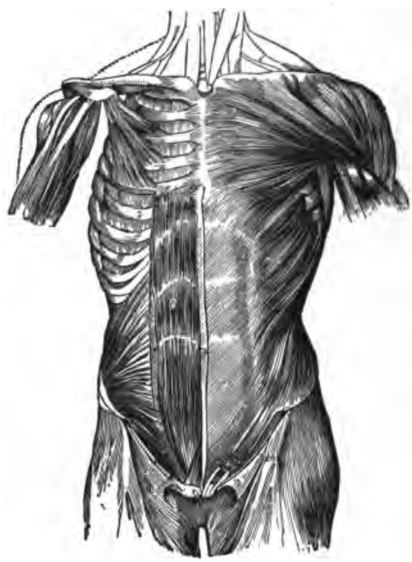


FIG. I.

SHOWING MUSCLES OF TRUNK, THE SKIN, ETC. HAVING BEEN REMOVED.

Probably all here know what muscle is. In the lower animals it is their muscles which form the red juicy meat, known as the lean of meat, in contradistinction to the fat. A beefsteak is simply a slice of a muscle from the cow.

Now, our muscles are of two kinds. The greater number, in fact all those forming our limbs and the trunk of our body, are termed voluntary muscles—voluntary, because they are under the control

of the will, that is to say we can, whenever we choose by a mental act, cause them to move. Thus, if I bend my arm I do it because I have, by a mental effort arising in my brain, compelled a muscle to contract and move the bones to which it is attached; although from long practice many of our movements become automatic, and we perform them almost unconsciously. Thus, when we walk or talk, or write, all the movements necessary to perform these acts, have by long practice become so easy that we do them without being conscious that we are directing those movements.

There is another and much smaller class of muscles in our body over which we have no control, and whose movements we cannot direct, and which are, therefore, named involuntary muscles; as instances of these may be cited, the muscular walls of the stomach and intestines. When we take food into our stomach a series of movements is at once begun, by which its contents are moved and rolled about, so that digestion may take place, and the food be properly mixed and prepared for the purposes of nutrition, and passed along into the intestinal canal. Of these movements in the healthy condition we are scarcely conscious, and have no control whatever over them: in diseased or unhealthy states we become very conscious of them by the pain produced, but even then we have no power to control or prevent these painful movements.

Of these muscles, viz., the involuntary ones, I shall have but little to say.

There is one other kind of muscle in the body which stands as it were between these two, and that is the muscle of which the heart is composed.

The heart is the organ whose work it is to pump the blood to every part of our system, and may be roughly compared to a bag or hollow ball, composed of muscle, which, as soon as it becomes filled with blood, contracts and forces it out, and thus filling and emptying is a work that must go on night and day, from the first moment of life until the time of death; in fact when the heart ceases to contract, or in common language "ceases to beat," life ceases, and so it has been very wisely arranged that this muscular movement of the heart is beyond the reach of our will; we have no direct control over it, and in this respect it resembles the involuntary muscles, although in general appearance and structure it is almost the same as the voluntary muscles.

Now if we look very closely at a muscle that has been cut across (say a piece of beefsteak) we can see that it is made up of a number of bundles, and when these bundles are examined still

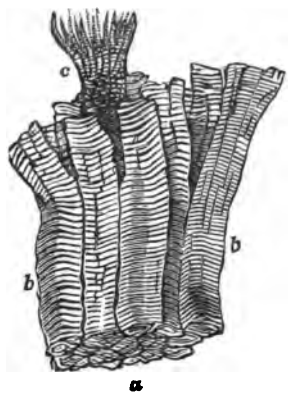


FIG. 2.

BUNDLES OF MUSCULAR FIBRES *b*, WITH SMALLER FIBRES *c*.

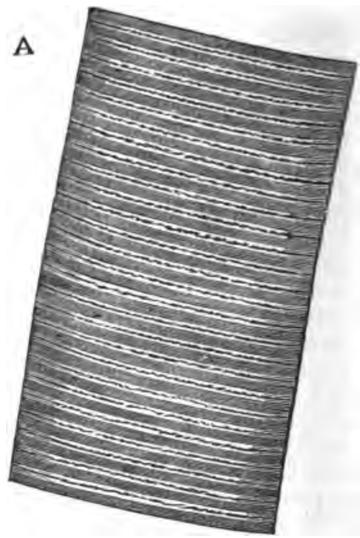


FIG. 3.

SMALL MUSCULAR FIBRE HIGHLY MAGNIFIED, SHOWING TRANSVERSE MARKING.

closer, and by the aid of a microscope, they are found to be made up of a vast collection of very fine fibres, which are termed muscular fibres, and each of these minute fibres is seen to be marked in a very pecular manner; they have running across them a number of lines or stripes, and from this peculiar marking they are named striped muscles, as distinguished from the involuntary muscles which have not these markings, and hence the latter are also termed unstriped muscles.

Such, very briefly, is the structure of a muscle.

I have already stated that the use or function of our muscles is to produce the various movements and actions of which we are capable, and which really constitute our very existence. Now, these movements depend upon the property which muscle, or the muscular fibres possess of stretching and contracting, and which may be for our present purpose compared to that of elastic india-rubber bands.

Now, this muscular contraction may be brought about in various ways, first and principally by the exercise of the will, through the nervous system. Thus, when I bend my arm, it is because I voluntarily contract the muscles here known as the biceps, the contraction and shortening of which is very evident, both to the sight and touch, in the bared arm. The same with the muscles of the

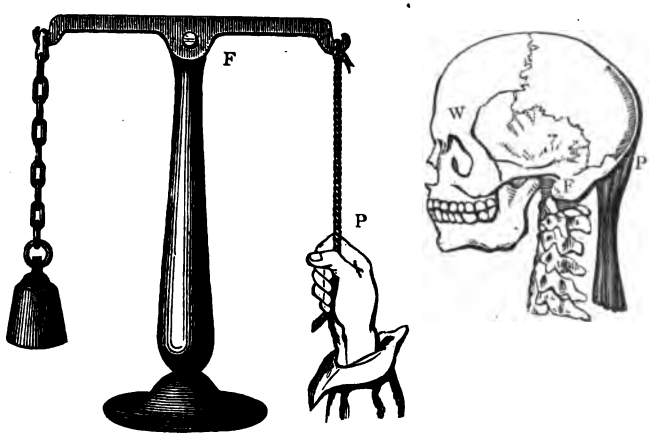


FIG. 4.

LEVER OF THE FIRST ORDER.

calf of the leg; or this contraction may be called into play by a mechanical stimulus; thus, if a smart blow be struck upon the muscle, it will contract. Another powerful means of causing contraction is by passing an electric or galvanic current through it. [*A demonstration was here given of the contraction of a muscle taken from a frog, when stimulated by a galvanic current.*] Most of you have at some time or other, probably, experienced cramp;

now, this so-termed cramp is nothing more or less than a painful irregular contraction of a muscle, often produced by cold, as when bathers are seized by it in the water, and which is so powerful that they are unable to overcome it, which fixes the limbs so that they cannot move them, and thus causes them to be drowned.

Another and severer form of what may be called cramp is seen in some diseases, and also as the result of certain poisons; thus in strychnia poisoning, all the muscles of the body are powerfully and violently contracted, so that the muscles by which we breathe and even the heart itself, is prevented from moving, and the sufferer dies a frightfully painful death.

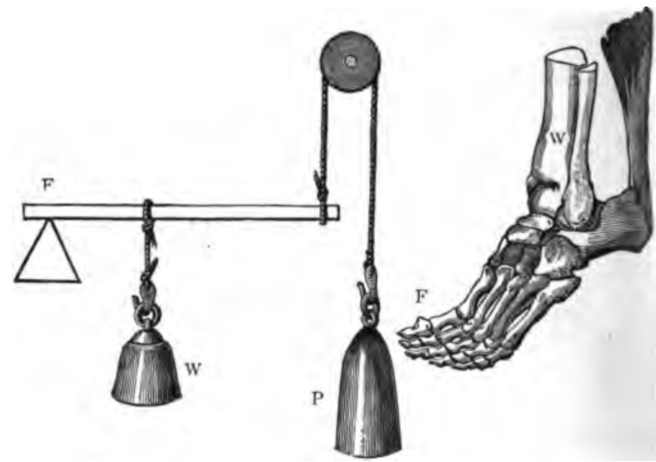


FIG. 5.

LEVER OF SECOND ORDER.

Something of the same sort occurs in cases of hydrophobia, or tetanus, and of lockjaw. An exactly opposite condition is seen in cases of paralysis, or, as it is termed in common language, "a stroke." Here the muscles, instead of being contracted, are flaccid and helpless, and the patient is unable to contract them at all.

Now, having briefly considered the structure and the properties of muscle, let us for a few moments consider the manner in which

these properties are made use of for all the purposes of movement, action, and work.

All who have any elementary knowledge of mechanics will know that among the commonest forms of mechanical appliances is the lever, and that levers are divided into three classes. In the first, the fulcrum F is in the middle, the power P at one end, and the weight or resistance, W, to be overcome, at the other. (Fig. 4.) We have an illustration of this in the movements of the head upon the spinal column, where the joint upon which the head moves is the fulcrum, the muscle P at the back is the power, and the front part of the head and face is the weight.

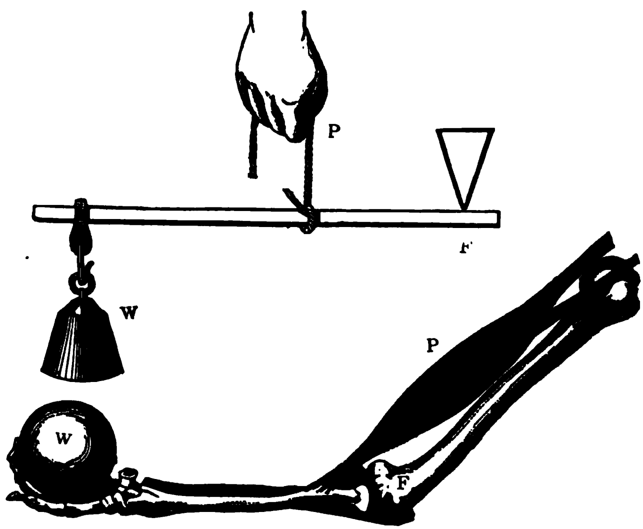


FIG. 6.

LEVER OF THIRD ORDER.

In the second class of levers, the fulcrum F is at one end, the power at the other, and the weight in the middle. (Fig. 5.) We have an example of this when the body is raised upon tip-toe, where the toes are the fulcrum F, the legs with the weight of the body is the resistance to be overcome, and the muscle P at the

back of the leg, which by contracting raises the body, is the power.

In the third order, the fulcrum F is at one end, the weight W at the other, and the power P is here in the middle. (Fig. 6.) The movements of the forearm afford a good illustration. Thus the elbow joint is the fulcrum F, the arm and hand, with anything the latter may hold, is the weight, whilst the power is the muscle P, the biceps, acting midway between the fulcrum and the weight.

Thus you will see that the body is really a complex machine, made up of various levers, the bones, which levers or bones are brought into use for the purposes of movement by means of the various muscles which are attached to them, and the more we study the action of these muscles and levers the more wonderful is their mechanism found to be.

We have all seen some of the various complicated pieces of machinery of the present age, but the most complicated and delicate piece of mechanism yet invented and made by man is simple and clumsy compared with the wonderful mechanism displayed in the most ordinary and common-place movements of our bodies. When we walk or run or jump, a variety of complex and co-ordinated movements take place. Or take the movements of the hands when playing upon the piano or organ; as we listen to the music produced thereby, we take little heed of the complicated and co-ordinated movements which are concerned in the production of the harmonious sounds. What this co-ordination of muscular movement really is even the most apparently simple action will illustrate. Take the case of a person, say an adult, whose education has been neglected, commencing to learn to write, what can be more clumsy than the way he handles pen or pencil, as he learns to make the simple strokes and curves of the elements of writing? Now, it is by the educated movements of various groups of muscles, aided and directed of course by the mind, that we arrive at that kind of work known as skilled labour. Numerous instances will at once rise to your mind. For example, the work of a watchmaker or jeweller; these workmen handle with dexterity and precision the small and delicate materials used in their occupation, materials which, to hands and fingers untrained, would be scarcely felt, much less manipulated; and in fact in all occupations classed under the head of skilled work, the same thing is seen, by long and continuous practice the most complicated and delicate manipulations become easy of execution.

Distinguished from this highly skilled work is that which we call manual labour, in which comparatively little skill is required, and in which the smallest amount of mental exertion and intellectual power is called into play: such is the occupation of the ordinary labourer and navvy, whose work consists chiefly in carrying, digging, loading, and the like, and where a large amount of muscular energy is expended in simply overcoming the dead weight, the *vis inertia* of inanimate matter. This form of muscular work is seen in the simplest perfection in the work done by the lower animals, such as the horse, whose powerful muscles are utilised by mankind for so many useful purposes. Still, looking at the body as a complicated machine, it is evident that if the maximum amount of work is to be got out of it, it must be kept in good working order, maintained in a sound condition, and supplied with the necessary motive power. Now, the source of all motive power in our bodies is the food we eat and drink; in fact, food serves much the same purposes in our economy as the fuel supplied to a steam-engine, from the combustion of which the motive power of the engine, steam, is derived. If proper fuel is not supplied the working of the engine is interfered with, and in like manner, if we do not get proper or sufficient food, the work of our bodies is interfered with.

It scarcely comes within my province to-night to speak to you much concerning the foods found to be best at different ages and under various circumstances, according to the work which the body has to perform, as a future lecturer will take this as a special subject for consideration; but there is one point which I cannot let pass without some brief reference, as such mistaken notions are oftimes prevalent concerning it in connection with our working power, and that is the consumption of alcoholic liquor as a food, or as a help to us in our work.

I do not come before you this evening as one who totally condemns the use of alcohol, or asserts that under no circumstances is its use beneficial, for I believe that, like all powerful agents, it has its proper and useful place; but I do assert, and that unhesitatingly, that the use of alcohol in any shape or form as a food—that is, as a means whereby we expect to nourish and strengthen our body, if that body be healthy, is totally and utterly a mistake.

It is no uncommon thing to hear people say that they could not do such and such kind of work without the help of a certain amount of alcoholic drink. Now, this is either untrue, or, if true,

then they have already arrived at a condition which is a long way removed from that of health. I am not giving you my own opinion merely upon this subject; if anything has been proved by actual experiment by numerous careful and unprejudiced observers, it is this—that the human body in a healthy condition is capable of greater and more prolonged exertion—can better bear severe privations and hardships, without rather than with the use of alcohol. As evidence of this, I would refer you not only to the experiments of such men as Parkes on individual persons, but also to the experience of those who have had the care and charge of large numbers of men when engaged in the operations of war under the most varied climates and conditions, or in the prosecution of great engineering undertakings, involving an enormous amount of individual physical exertion. Perhaps one of the most striking examples which can be adduced in support of this is the evidence of those who have conducted explorations in the severe cold of the Arctic regions. It has been distinctly shown that those men who have taken no alcohol whatever have best borne the cold and other privations to which they were subject. Perhaps some of you may have seen in the daily papers of the present week that on Tuesday last Weston, the well-known pedestrian, commenced a walk which, if completed, will far surpass anything done by him before, and is calculated to test his powers of endurance to the utmost, viz., to walk 5,000 miles in 100 days, and in doing this he will take alcohol in no shape or form.

I do not say, nor, I think, would any unprejudiced person who has paid careful attention to the subject say, that the use of fermented liquids, such as beer and light wines, taken in moderate quantities, and with solid food, is productive of any ill, but to a healthy man they are, at least, unnecessary, and if people would only be candid and tell the truth about the matter, and about which I see no cause for shame, they would say they take them because they like them, n the same way that we take, for instance, various sauces with our food. If I have a nicely-cooked mutton chop placed before me, and I am in good health, I am able to eat it without the addition of any appetising sauce. I may take some because I like the flavour of it, but it will not increase the nourishment to be derived from the chop. The same with beer and wine. On the other hand, I may take the sauce as a stimulus to my appetite, or to improve the flavour of the chop, especially if this be badly cooked; but this only shows that either my appetite or

the chop is at fault. And so with drinking alcoholic beverages. They may be taken, and often are, as a fillip to the appetite, which is evidence itself that the condition of the system is not altogether what it should be; or, as I believe is very often the case, especially among the labouring classes, it is taken as a help to improve poor or badly-cooked food, which is frequently deprived of half its palatable qualities by the bad cookery of an incompetent wife.

These remarks apply solely to the taking of what are termed moderate quantities of alcoholic drink. As to their effect when taken in large and excessive quantities, not only in lessening the working power of the body, but also in producing actual disease and injury, it is quite unnecessary for me to say one single word.

And in making the above observations I have been alluding chiefly to fermented liquids, such as beer and wine; as for the products of the still, that is, strong spirits, I have nothing for them but condemnation as articles of food in every shape and form.

A word in passing as to what is meant by "spirits." We talk of alcoholic drinks in a somewhat loose fashion. All those drinks termed intoxicating liquors depend for their power of intoxication upon the presence of alcohol. Alcohol, pure and simple, is a colourless limpid fluid, of a highly inflammable nature, and known commonly as spirits of wine. In beer there is about five to ten per cent of this spirit present, say about two tablespoonsful in a pint; light wines contain about double this quantity: and strong wines three or four times this amount; whilst spirits, such as whiskey and brandy, are almost pure alcohol, containing eighty or ninety parts in every one hundred. The essential difference between the various spirits sold being due only to small quantities of flavouring and colouring matters.

Comparatively small quantities of pure alcohol, a few ounces only, when taken into the system, produce very marked effects, and if indulged in beyond a certain extent, produce profound stupor and insensibility, which may and does sometimes go on to death, so that to all intents and purposes it may in its concentrated form be looked upon as a poison, and if taken constantly and regularly as an article of food, cannot but do harm. The immediate effect is, as all know, a stimulating one; a man feels apparently stronger and more vigorous, and during the short time that the effect lasts, is perhaps so. Any of you who have seen a man in the condition known as "mad with drink," will have

witnessed the powerful stimulating effect it has upon the muscular system, so that it may require half-a-dozen men to control his violent and maniacal movements; but this condition of apparently increased power is quickly followed by reaction; all know the condition of that man on the morrow, the dry tongue, the headache, the loss of appetite, and the shaky hand, all show how powerfully the system has been affected by it. This same shaky and unsteady hand is due to the fact that the muscles of the arm and hand share in the general disturbance, and cannot properly do their work; and in the case of those whose work as skilled workmen require their hand to be perfectly steady and reliable, too often leads them to repeat the dose in the morning, and thus a habit of spirit drinking is established. The artificial stimulus produced by alcohol may well be compared to the application of whip and spur to a horse; it answers for the moment, but its effect soon passes away, and if it is necessary to be constantly and continually used, shows that something must be radically wrong somewhere.

Perhaps some may ask—Are there then no circumstances or conditions in which this alcohol which has been shown to have such powerful properties is useful and serviceable? To this I would answer yes, as a drug possessing powerful properties, it has its proper use and place.

Let me give you an example which you will all understand, and which has a direct bearing upon muscular work. I have already spoken of the heart as being a muscular pump, whose function it is to force the blood to all parts of the body. Now, in certain diseases, and especially in fevers, great weakness and exhaustion of all the muscles ensues, and the heart suffers with the rest of the muscles in this exhaustion to a very great degree, so much so that life is often in danger from the failing power of the heart, and it becomes too weak to pump the blood through the system. Now, in such a case as this, alcohol, by its stimulating power, acts in the same way as a spur to the jaded horse, and may keep the heart's action from entirely failing until the danger and the crisis is past; but this of course is a very different thing to taking it constantly into a healthy body. Let me then once more impress upon you this fact, if you learn no other to-night, that for all healthy working powers alcoholic drinks are unnecessary. Fermented liquors, such as beer and light wines with meals, have not been shown to be harmful; but ardent spirits

in any shape or form, to a healthy man, can but be a source of danger and possible harm.

I have enlarged somewhat upon this subject of alcohol in its relation to work, because there is abroad, and especially has been in the past, a wide-spread and mistaken idea that strong drinks are absolutely necessary for those engaged in hard work.

You are all familiar with the phrase "in training," as applied to men who are preparing for some competition of skill, or some task of endurance, such as rowing, running, walking, football, or ordinary athletics. Now, the object of training is to get the body, and especially the muscles of the body, into the best possible condition, and experience has taught that men in training for these various muscular efforts are best prepared by abstaining from the use of alcoholic drinks. But if the uselessness of strong drink as an article of food is thus to be insisted upon, it is necessary quite as strongly to insist upon the necessity of a regular and proper supply of food, if our muscles are to be kept in a healthy and robust condition.

The muscles, like all other parts of the body, are nourished by the blood, which flows through them in a constant stream in many thousands of minute channels. Every action we perform, every movement we make, is accompanied by the wear and tear of some one or more muscles, and it is necessary for their repair that proper material be brought to them in the blood for this purpose, and as the blood is formed from the food we eat and drink, it is essential that we take sufficient and proper food, and what is of quite as much importance, that it be taken at regular intervals. I shall not enlarge further upon this subject of food, as amongst the present series of lectures is one on eating, when the lecturer will probably discuss the matter fully.

For the same reason, I shall touch very briefly upon another point which directly affects our working powers, viz., a constant supply of pure air for breathing purposes, without which no healthy condition of the body can be maintained. Many who are employed at large works, factories, and shops are, of course, dependent to a great extent upon their employers for the proper ventilation and supply of fresh air to the rooms in which they are employed, but there is one period of time, and that one of the most important parts of our existence, when this matter is under each person's own control—viz., during our sleeping hours. If you consider how much time in every twenty-four hours is spent

in sleep, nature's restorative to the tired limbs and weary body, and consider how important a factor is the breathing of pure air in that restorative process, you will at once see the necessity of making provision for a proper supply to our sleeping rooms. And yet this very point is one that is often not only forgotten or ignored, but special means are taken to keep out the air by stopping up every crevice and crack, and even blocking up the fireplace and chimney where one is present. Many a case where languor and debility are experienced on rising in the morning, instead of freshness and vigour, is due to the breathing for many hours of impure and unrenewed air. People seem to have a dread of "night air," as though it were different to the day air. In ordinary climates, the chief difference is simply one of temperature; and better to knock out a few panes of glass from a bedroom window than close up every hole. Wherever there is no fireplace in a bedroom, or the room is small, the window should be left open for an inch or two. Much more harm has been done by the absence of fresh air than by the admission of too much, even if it be somewhat cold.

One other point I should like to refer to in connection with the subject of working.

Manchester and Salford possess an unenviable notoriety of a very high death-rate, that is to say, there die each year in every thousand of the population a much larger number than would be the case if all were living under healthy conditions.

Now, this high death-rate is largely made up by the deaths of an enormous number of young children, and especially very young ones, and there is little doubt that one of the chief factors in the production of this sad condition of things is the practice so prevalent in this district of the mothers going from home to work, leaving their infants to be improperly tended and fed during their absence. If fathers and mothers could only be made to see and understand that, where it is not really necessary for actual maintenance, the mother would be doing her young children an incalculably greater amount of good by stopping at home and properly feeding and tending them than by the extra money which her labour at the mill brings into the family treasury.

And now before I conclude I must say a few words upon what may be called the counterpart of work. It is an old saying that "all work and no play makes Jack a dull boy." The same is true of men and women as of boys. It is absolutely essential for

the health and happiness of every man that he shall have certain intervals of rest from his work; and by rest I do not mean simply the rest which sleep affords us, nor is it simple idleness or waste of time that is required, but some healthy recreation, it matters but little what, provided it is not of an injurious nature to the body.

Recreation is a mere relative term. What is one man's work is another man's amusement. To him who works chiefly with his brain, it is a recreation to indulge in some physical exertion; to him who has had to work all day at some hard manual labour, a quiet pipe, with book or paper, will be a source of recreation. The great thing to be aimed at is, that there shall be a complete change of thought and action. It is in this way that the volunteer regiments supply a healthy means of recreation to hundreds of young men, whose daily labour compels them to spend many hours shut up in warehouses and offices. To very many, probably, the actual physical labour involved in their drill is much greater than that of their daily work, and yet it is, to all intents and purposes, a recreation for them.

Probably few men in the country work harder or have more anxiety and care than the present Prime Minister, and yet we are told that one of his favorite sources of recreation is in the laborious work of cutting down trees. Thus we see that recreation and rest consist not in mere idleness, but in some form of agreeable occupation. For the well-being of our muscular system, and that it may be kept in the most healthy and robust condition, it is necessary that every muscle should have a fair amount of use and exercise; and hence the desirability of those engaged in sedentary occupations, and for those who are engaged in skilled labour, and whose work calls into play only a few muscles of the body, to engage in some form of recreation that calls into play the muscles which they least use at their work, such as simple walking, or our various out-door games, or a moderate use of gymnastic exercises. You know how our muscles grow and become stronger by use, as seen in the case, say, of a blacksmith, whose brawny arms become as strong as iron bands, from the exercise they get in wielding the heavy hammer at his work. On the other hand, muscles that are not used, but are kept idle and unexercised, become smaller and weaker, and ultimately more liable to injury and disease.

Work, like all things else in this world, may be abused and misused, either by an excess or deficiency of use; but I think it would be easy to show that over-work has done far less harm in

the world than the opposite condition. There can be but one answer to the question—For what purpose are we sent into the world? It is to work, and it is for each and every one of us to see that we use our powers, whatever they may be, to some useful purpose, for there can be no more bitter reflection to a man when looking back on his past life than to know that that life has been half wasted; and how much more he might have accomplished had he only steadily applied himself to work. Let us all then determine that whatsoever our hand findeth to do, to do it with all our might, for we have it on the highest authority that "To all labour there is profit."

DRINKING.

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MAN is sent into this world to work. All men work mentally or physically. But some men work too much, while others work too little. As a rule, perhaps, those who work too little are less happy than those who work too much. There is no surer road to all round happiness than a wise system of hard work. Our Creator has given us all plenty to do, if we will but do it. But work in any shape implies the possession of energy. We cannot work without energy. Some, let us hope not very many, of our friends of the press, the pulpit, the bar, and of the bench (including also the workshop bench), and, in fact, of all professions and occupations, at times try to drink in that energy in the form of strong drink; how vain the attempt I hope the latter part of my lecture will show.

It has been calculated that a strong, healthy man consumes, in the course of one year, about twenty times his own weight of food and oxygen. He passes into his body during each twelve months about 800 pounds of solid food and 1,500 pounds of liquid (drink, if you like to call it so). Why does he thus store away in his body all this solid and liquid substance each year? Simply because within it is hidden away the energy without which he can do no manner of work. The food he daily passes into his system supplies him with *energy* he cannot create, but without which his body would be a useless organism. But why also does he take into his system this 1,500 pounds of liquid per year? He takes into his system annually this large mass of substance simply to assist him to prepare the solid food he takes, so that he may be able to obtain from it that supply of energy which his Creator locked up in that food for his wise use, and to assist in regulating the action of that

mysterious organisation (his own body) by which the *latent energy* of the food is liberated into the active forms of muscular and mental work. Unfortunately, however, a too large number of our fellow-creatures, pass daily, year by year, so long as they manage to last, liquids (strong drinks they call them) into their bodies which diminish their energies, lessen their work capacity, and destroy in place of regulating the very organisation it is their duty and their interest most to conserve.

But how is the stored-up energy of the 800 pounds of solid food, annually consumed by our typical adult man, made to give up its energy in locomotion and other forms of muscular movement, in thought-making, and in keeping the general machinery of his organisation in health and good repair? The "how" of this was probably never more simply and clearly explained to an audience than it was explained by our president, Dr. Ransome, in his lecture on "Breathing," delivered in this room a few weeks since. Before this food can be made to give up even the smallest portion of its energy to the human body, for muscular or brain purpose, it must be built up into the substance of blood or of body tissue and then *burnt.* To do this *burning*, 800 pounds of oxygen gas are annually removed from the atmosphere and passed into the blood, by the lungs, during the process of breathing.

We thus see the source of our bodily, our human energy. The one ton and a half of substance we thus annually pass into and consume (burn away) in our bodies is the source of that energy. It is one object of the lectures promoted by the Manchester and Salford Sanitary Association to teach you to use this annual ton and a half of matter wisely and well.

To the process by which blood is made out of food the physiologist applies the term Digestion; to the process by which the blood is built up into body tissue, as nerve, brain, muscle, &c., he applies the term Nutrition; while to that by which the tissues of the body are burnt up as they liberate the *energy* by which they perform their respective duties, just as a candle gives up its light and heat as it is being burnt, the physiologist applies the term Respiration or Breathing. The science of each of these processes has been most ably expounded and elucidated from a popular point of view by my predecessors on this platform, and you will find few more instructive lectures on these subjects than the Health Lectures published under the auspices of the Manchester and Salford Sanitary Association by Mr. John Heywood.

I propose to treat my subject this evening after the good old-fashioned plan usually adopted in the pulpit, viz:—The three-head plan; firstly, secondly, and thirdly, together with the application or moral.

Under these heads I propose to enquire:—

Firstly —*Why* we drink?
Secondly—*How* we drink?
Thirdly —*What* we drink, or rather what we should drink?

We drink for a three-fold reason. Firstly, it facilitates the process of swallowing, and the admixture of the saliva and other digestive juices with the food. It also, by softening and liquefying the masticated solids, assists in setting up the series of physico-chemical changes which in the aggregate constitute the process of digestion.

Secondly, it supplies the *fluid vehicle* by which both nutriment and oxygen are floated or carried to the various tissues of the body, and by which the *poisonous waste* of the burnt tissues is carried to the various organs whose duty it is to expel it from the body. No liquid performs these important *vehicular* and *flushing* duties so well as pure water.

Thirdly, it regulates the animal heat. When the temperature of the blood rises much above its normal height, 98 degrees Fahrenheit, the nervous system ceases to be able to perform its functions healthily. If the temperature of the blood rises up to 107° or 108° Fah., life becomes endangered, and if the temperature be not reduced within a moderate period of time, death becomes certain. It has been calculated that enough heat is generated in the human body in the course of each thirty-six hours to raise the temperature of the whole of the body to that of boiling water. To prevent this result the skin and lungs pass off daily from the body two to three pounds of aqueous vapour chiefly in the form of *perspiration*. The act of perspiring cools the body, just as the forming of steam during the boiling of the water prevents the kettle from becoming red hot when on the top of the fire. When the skin becomes too hot through a deficiency of fluid in the blood to supply the necessary quantity of perspiration, we become feverish and thirsty. Water is the best drink for supplying this deficiency and for quenching this thirst.

I now proceed with equal brevity to the consideration of our second head, viz.:—*How* we drink? Under this head is also

included the question, whither goes the drink immediately after its entry into the stomach and intestines? The act of drinking itself is a pure pneumatic process. Were there no air we could not drink. Allow me to ask you to give your best attention to what takes place when you drink a cup of tea. You place the cup to your lower lip, gently pressing it against the soft lip so as to form an air-tight contact with it. You then close up your mouth, bring the roof of the mouth down on to the top of the tongue, so as completely to close up the whole cavity of the mouth; you then bring the upper lip down just under the level of the liquid in the cup, thus forming a sort of water valve cutting off all connection between the mouth and external air. Simultaneously with this you press backward against the top of the pharynx (food pipe), a soft pendulous body at the end of the palate bones, termed the velum or soft palate, and thus temporarily shut off the passages connecting the mouth with the nose. You now enlarge the cavity of the mouth, and if you want to take a full draught, you also slightly inflate your chest, keeping all the parts mentioned in their previous positions. A partial vacuum is thus formed in the mouth, and the pressure of the outside air (about 15 pounds on the square inch) immediately forces the liquid into the mouth and down the throat (the food pipe) into the stomach. When an acrobat "stands on his head" and drinks a glass of water in that position, the pressure of the air drives the liquid *up* his throat into his stomach. We thus unconsciously drink on purely barometrical principles. In some cases a child is born with what is termed a perforate palate, that is, a natural opening exists between the nose and the roof of the mouth. In such a case the afflicted person cannot drink unless the perforation be closed by a silver plate, or by some other artificial means, or unless the sides of his nose be pinched together to prevent the entrance of the air.

I have arranged here a simple experiment for illustrating the physical action of "drinking."

Into this large glass basin, containing some coloured water (coloured simply so that it may be seen at a distance), I dip down an inch or two a long glass tube of about an inch in diameter. To the upper end of this tube I have attached by means of an air-tight india-rubber tubing a Dr. R. A. Angus Smith's bellows. These bellows consist simply of an ordinary accordion body or bellows, the interior of which is cut off from all com-

munication with the external air. When I enlarge the bellows by drawing the upper and lower walls asunder, a partial vacuum is produced in their interior chamber, and also in the glass tube connected with the same. The downward pressure of the air in the interior of the tube being thus reduced, no longer balances that of the air outside, which accordingly, as you see, pushes the contained liquid up the tube. The action of drinking thus precisely resembles the so-called suction principle of the common pump.

In the manner then, just recently described, the water or other liquid enters the stomach, and through its lower aperture also the interior of the intestines; but having arrived in these regions what becomes of it?

The walls of the stomach and intestines are covered with a comparatively close network of bloodvessels, consisting of veins and arteries of various dimensions. The veins and venules collect and convey the impure purple, or dark-looking blood, from the coats of the stomach and intestines on its way to the liver to undergo a partial purification. The venules (small veins), and the venous capillaries possess the power of rapidly absorbing water and many other fluids. When, therefore, water, or other similar fluid, not requiring digestion, passes into the stomach and intestines, a large portion of it becomes immediately absorbed by the bloodvessels referred to, and is conveyed to the liver, thence to the heart, lungs, back again to the heart, and thence to the rest of the system. On thus entering the general system, one of the earliest visits made by the newly absorbed drink is to the kidneys. I wish you specially to note this fact, as I shall again have to refer to it when speaking of disease produced by alcohol drinking. You will also have observed that the absorbed drink has already visited the lungs. If our blood be thus loaded with alcohol, or other tissue-irritating substance, is it surprising that these organs—I mean the liver, kidneys, and lungs—should so speedily become injured?

In order a little more completely to answer the question, "Why we drink?" it will be necessary that we take a short outline-view of digestion. Digestion is the process by which the nutritious are separated from the innutritious parts of the food, and the former are converted into blood. The process of digestion, so far as solid food is concerned, consists essentially in a breaking up and dissolving or liquefying the nutritious or blood-forming portions.

This process consists as it were of several sub-processes. The chief of these sub-processes are mastication, insalivation, deglutition (swallowing), chymification, chylification, and absorption. By mastication, or chewing, the food is broken up into small particles, and thus more easily dissolved, a matter of the greatest importance in all cases of feeble digestion. While the food is thus being broken up, chiefly by the action of the teeth, three pairs of small bodies, termed the salivary glands, are engaged in elaborating out of the blood, and pouring into the mouth, a peculiar fluid, the *saliva* or spittle. The saliva contains a peculiar organic principle, called *ptyalin* or *salivin*. The presence of this principle with the food is absolutely essential to the solution and digestion of all *starchy* matters. Bread and other farinaceous matters are therefore absolutely indigestible if not acted upon in the body by the *saliva* or other similar fluid. The *starch* which forms the chief mass of bread, and which itself is insoluble, has first to be converted into *grape sugar*, and thus rendered soluble. This is the work done by the ptyalin of the saliva: it converts the starch into grape sugar, which is then readily dissolved and soaked through the walls of the venules and capillaries of the stomach and intestines, and thus mixed with the blood, as previously described. This mixing of the saliva with the chewed food, during the act of mastication, is called insalivation. Hence, we see the importance of due insalivation and the injurious effects of insufficient insalivation. Hence arise the bad effects of bolting the food. The starchy parts of the food being insufficiently supplied with ptyaline, remain in the stomach and intestines undigested, ferment, and give rise to dyspepsia with flatulence. A moderate amount of fluid taken with dry food promotes the interpenetration of the saliva into the mass, and thus promotes swallowing and digestion in general. But an excess of liquid lessens the action of the salivary glands, the more liquid or juicy the food the less saliva poured into the mouth. Excess of fluid taken with the food therefore lessens the quantity of that secretion, and impedes the digestion of bread and other starchy foods. In this way it not unfrequently happens that a person cannot take an ordinary basin of boiled bread and milk for supper without suffering from flatulence, while if he eat the same quantity of bread, dry, alternately with drinks of milk, no such flatulence is produced. In the latter case the bread, before being swallowed, is duly saturated with saliva. We thus see that not only the drink, but the mode

of taking it is a matter of importance. In order that you may all judge for yourselves the importance of the saliva and the injurious effects of bolting the food, on digestion, I beg to introduce to your notice two experiments I have arranged with this object:—

Experiment I.—Into one of these glass tubes I have introduced a small quantity of starch, into this same tube I first introduce a small quantity of this blue solution of copper sulphate (blue vitriol) and then a small quantity of solution of potash. You see it now changes colour, becoming opaque, and of a light blue colour. I now boil it in the flame of a spirit lamp; you see it burns black almost immediately.

Experiment II.—I now repeat the experiment with one slight modification only. My friend, Professor Thomson, of the Royal Institution, has been kind enough to prepare me this afternoon an infusion of starch in all respects similar to that I have just used, except in this most important respect that his assistants were asked to spit (saliva only) into the starch. This tube, therefore, originally contained a mixture of starch and saliva. Into this mixture I, as before, add, first, solution of copper sulphate, then solution of potash, getting as before a light blue precipitate. I now apply the spirit lamp and boil as before. But you will now observe that the blue precipitate turns, not black as in our last experiment, but to a bright ruby red. This ruby red precipitate is due to the presence of grape sugar, thus showing that the saliva (spittle) converted the starch into grape sugar, and thus imitating out of the body what takes place in the stomach during the process digestion.

Experiment III.—Into this weak infusion of starch and water, I drop the smallest possible quantity of potassium iodide, and then a few drops of a solution of potassium nitrite. The liquid immediately changes to a dense blue colour, clearly showing the presence of *starch.*

Experiment IV.—Into this glass I pour what formerly consisted of a mixture of *starch* and *saliva.* I pour as before a drop or two of potassium iodide, and then some potassium nitrite. The solution no longer turns blue as before; the starch has, therefore, disappeared, having been converted into *grape sugar* by the action of the *saliva.*

The next stage in digestion is Chymification. The food, having passed through the mouth and œsophagus (food pipe), becoming duly mixed with the saliva, now enters the stomach. It here

becomes mixed with an additional fluid secreted by the walls of the stomach, termed the *gastric juice.* This fluid, which consists chiefly of water slightly acidified, contains a peculiar organic principle termed *pepsin.* This pepsin enables it to dissolve nitrogenous or albuminous bodies, as boiled white of egg, flesh fibre, &c. But it only possesses this power in a marked degree at the temperature of the blood (98° Fahrenheit). If cooled down much below this temperature it loses much of this solvent or digestive power. Large draughts of cold liquid, whether beer or water, therefore impede digestion, both by lowering the temperature of the stomach, and by diluting too much the strength of the gastric juice. Large draughts of cold drinks during the taking of a meal are, therefore, especially injurious to those suffering from indigestion.

As a rule, if much fluid be required by the system, it is best to take it some time before, or some time after an important meal. A moderate quantity of water, drunk some time after a meal, probably promotes the secretion of the *pepsin*, the absorption of the digested contents of the stomach and intestines, and also the propulsion of the indigestible portions of the food along the intestines. Strong spirits tend to solidify and precipitate the pepsin, besides irritating the coats of the stomach, they thus impede digestion.

As an illustration of what is meant by precipitation in a solid form by alcohol, I beg to draw your attention to the following experiment:—

Experiment: Into this clear solution of gum in water pour a small quantity of alcohol. The whole becomes immediately of a milk-white appearance. The alcohol tears the watery solvent away from the gum, the latter being precipitated (separated) in the form of a white powder.

Many persons suffering from indigestion experience much benefit and comfort by drinking nightly, for a period, just before retiring to bed, from half-a-pint to a pint of *hot* (not warm) water. The water should be as hot as will allow of its conveniently being drunk.

The remaining processes of digestion, viz., Chylification or fat-digestion, and the discharge of the useless and indigestible portions of the food, are both promoted by moderate and discreet water-drinking.

We are now arrived at our third head, viz:—"*What* we drink?"

Under this head I also propose to include the enquiry, "What are the consequences of alcohol drinking?"

Water is undoubtedly the most natural and wholesome drink if perfectly free from certain impurities with which it is not unfrequently contaminated. All drinking water should be transparent, colorless, clear. It should contain no suspended matter, neither should it yield any appreciable deposit after remaining at rest for some time. It should be tasteless and inodorous.

Special care should be taken that it is not contaminated with coal gas, or with sewage gas, which not unfrequently happens in towns as the water passes on to the consumer. Typhoid fever is most probably chiefly spread in towns and villages by the use of drinking water which has percolated into wells from cesspools and other impure sources. People in Manchester are sometimes alarmed at a peculiar turbidity and whiteness occasionally present in ordinary tap-water. This turbidity, which disappears on standing, is simply due to the infiltration of air—that is, to the presence of myriads of air bubbles, and, therefore, need cause no alarm.

The late Dr. Parkes, the well-known hygeist, says a man requires about a third of a gallon per day of drink in the form of tea, coffee, or other fluid. In addition to this, 20 to 30 ounces of water are taken into the body, combined chemically into—that is, forming a part of—the dry solid food he daily consumes.

Water contaminated with organic matter, more especially such as sparkles in the glass (thus indicating the probable presence of salts containing nitrogen, termed nitrites), should be avoided, as being particularly dangerous. Impure water of this description is the great cause of death during war. At the siege of Ciudad Rodrigo, in Spain, the army lost terribly by dysentery. This loss was attributed by Sir J. McGrigor to the use of water which had passed through a cemetery containing 20,000 graves. Such water would have contained a large proportion of nitrites and nitrates. A pump near the Minories, London, highly appreciated for its sparkling and pleasant-drinking qualities, was, on one of the occasions when London was visited by the cholera, found to have acquired its peculiarities by having drained through the adjacent churchyard. During the recent invasion of Egypt by the cholera the mass of the people not only drank from canals or water courses into which sewage nuisance freely flowed, but in many instances they drank water which besides having flowed through cholera grave-yards, had, as it drained away, been used for washing the

dead bodies of persons who had died of cholera, before it was collected for drinking purposes.

Wherever water is suspected of having come from impure sources, as in the case of wells in almost all farm yards and in most villages, it should first be boiled and then filtered. In all cases it should certainly be boiled. If country visitors and tourists observed this precaution the life of many a man who returns home apparently full of health and vigour, to be in a few days laid down with typhoid fever, would be saved. The use of pocket filters, such as now may be purchased comparatively cheap, is greatly to be encouraged, but in such cases as those alluded to there is no ready substitute for boiling.

Occasionally accident offers as complete a scientific illustration of a fact as can the most perfect arrangement in the laboratory. The following is an instance:—In the year 1834 eight hundred soldiers in good health were shipped at Bona in Algiers, and carried in three vessels to Marseilles. Six hundred and eighty men arrived in two of the vessels with not a single case of sickness on board. In these cases the water was good, the soldiers having been supplied with drinking water from the ships. In the third ship, the Argo, 120 men embarked; of these men 107 arrived, of whom 98 were sick, the remaining 13 men had died on that short voyage. The crew also arrived safe and well; they had been supplied with drinking water from the ship. But the water supplied to the soldiers was what they had specially collected for themselves from a marsh. No clearer indication of the importance of the nature of the source from which our drinking water is procured could be obtained than is furnished by this case.

Rain water, especially in the neighbourhood of towns, is quite unfit for drinking, being contaminated with soot, the washings of the air, acid, dead or decaying leaves, and other matter; also with lead, zinc, &c., washed from the roof. Drinking water should never be kept in leaden cisterns; if the cistern-lid be also lined with lead, the lead on the lid will probably do more harm to the water of the cistern than all the rest of the lead put together. In the morning, before the water is drawn from leaden pipes, for drinking purposes it should be allowed to run for half a minute so, in order to empty the pipes of any lead that may have become dissolved during the night, or period during which the water has been at rest in the pipe. Great care should be observed in this respect on removing to a new house.

The presence of air in water not only makes it sparkle more, but greatly increases its refreshing qualities. Water that has recently been boiled, or water obtained by melting ice or snow, is not nearly so refreshing as recently drawn spring water, because of the absence of air, and carbonic acid gas. A gasogène, or apparatus for forcing carbonic acid gas through water, is therefore a very useful article in domestic life, possibly only a little less useful than a good domestic filter.

All our best domestic filters are made up essentially of animal charcoal, or of a mixture of animal charcoal and broken-up magnetic carbide of iron. If our filters in common every-day use be not frequently cleansed, their use may even augment the harm they are intended to avoid. Drinking water charged with much lime and magnesia, especially if associated with iron, tends to produce the disease so well known in Switzerland, termed *goître*, a milder variety of which in our own country is termed the "Derbyshire neck." In Switzerland it is more or less associated with idiocy.

Tea and *coffee*, two of our most common non-alcoholic beverages, are not nutritious, neither do they lessen the waste of the system; they act as stimulants only, exhilarating and causing wakefulness. Used in *very moderate* quantities they are probably not injurious. During Arctic voyages they have been found much better restorers and promoters of the animal heat than alcoholic drinks. They depend for their exhilarating qualities upon two principles, termed respectively *thein* and *caffein*. Tea contains a bitter principle termed *tannin*, which soaks out in large quantities on continued infusion or soaking, and also on boiling. Tea should never be allowed to stand more than ten minutes or quarter of an hour in contact with the leaves from which it is prepared. If the infusion is not to be used immediately, it should be poured away from the leaves into a second vessel. Warm tea promotes both perspiration and respiration, which, no doubt, forms one of the chief causes of the immediate relief it gives to a person when very fatigued and, as is usual in such a case, slightly feverish. Stewed tea in the middle of the day in place of a substantial meal injures the stomach, and tends to produce dyspepsia (indigestion) and to give rise to an irritable and hysterical condition of the nervous system, and, speaking generally, to lower the constitutional tone altogether.

Cocoa, less stimulating than tea or coffee, is more nutritious, and, therefore, much more wholesome than either of those as a

breakfast beverage to those who like its flavour. Its exhilarating principle is an alkaloid termed *theobromine.*

Coffee is probably (for those who like it) better for breakfast than tea, since it stimulates the heart, whose action is more feeble in the morning, and since it does not act so much on the skin, which is usually active in the morning.

Recent investigation tends to confirm the former teachings of physiologists in relation to the use of these beverages as parts of heavy meals. Dr. James Fraser finds, as a result of recent experiments, that all these infusions in general retard instead of promote digestion. The digestion of ham and white of egg appear to him not to be retarded by coffee. Cocoa and cocatina appear to him not to retard the digestion of fish. Tea, coffee, and cocoa also seem to retard the digestion of salt meats less than they do that of fresh meats. Tea in these cases has a tendency to produce flatulence. His more recent results, therefore, agree with those of former physiologists in condemning *meat teas.*

Milk, the natural food of the young, because of its high value as a nutrient, both acts as a food proper, and also as what is more technically called a drink. As milk consists of about 88 per cent of water and of 12 to 13 per cent of solid matter only, and inasmuch as a portion of the solid matter is not nutrient, any admixture of water with the milk in the way of adulteration becomes a most serious matter in the case of children who are fed upon it. It has been calculated that the public in London only, have been defrauded to the extent of nearly half-a-million pounds sterling annually by adulteration with water alone.

Numerous wide-spread attacks of virulent typhoid fever in various parts of the United Kingdom have been conclusively traced to the use of milk which has been conveyed from farms in cans washed with impure well water, so common in farm yards. Of its power to spread malignant forms of typhoid fever in this manner there can now be no doubt whatever. All milk used as drink, should therefore be first boiled, in order to kill the *bacteria* or disease germs which abound in it under the circumstances mentioned. Want of time prevents my saying more on this important subject during this lecture, further than that it is well for the public interests that borough analysts, health officers and sanitary authorities in general are already trying to attack and suppress the milk evils.

All the alcoholic beverages in common use owe their imagined usefulness to the alcohol they contain.

The term alcohol is applied by chemists to each of a class or series of bodies consisting of carbon, hydrogen, and oxygen grouped together in a certain special manner. Common alcohol, termed by the chemist ethyl alcohol, to distinguish it from other alcohols, possesses a composition expressed by the formula $C_4 H_6 O_2$. When perfectly pure and free from water it is known as absolute alcohol. Since alcohol contains no nitrogen in its composition, it *cannot* act in the body as a *structure-builder*—that is, it cannot by any possibility act as a bone, muscle, or nerve-former. It is therefore quite useless as a *nutrient* or a *food proper*. Further, all modern experience and investigation tends to show that it—especially when taken in any quantity—is worse than useless as a heat-former or a respiratory food, since it depresses instead of raising the temperature of the animal body, and that most markedly too in very cold climates, as those of the Arctic regions. Time alone prevents my adducing numberless instances and authorities in proof of this indisputable statement. Yet such is the dense popular ignorance in relation to this fact, that brandy "nips" and whiskey "nips" are still the popular panacea among large classes for "keeping out the cold." What these "nips" do is to stupify our nerves, so that we cannot know how cold we really are, or how cold we ought to feel.

Pure (absolute) alcohol is to the chemist, physicist, physiologist, medical man, and also in various manufacturing arts, an almost invaluable substance. It is at all ordinary temperatures a beautifully clear, colourless, transparent fluid. It has an acrid, burning taste, and a pecular distinctive odour; it is very volatile and inflammable, burning with a smokeless flame, and affording therefore to the practical chemist and in the arts a most valuable form of fuel. It boils at 173° F., but has never yet been frozen. It is a very powerful solvent for many substances, but it also precipitates other substances from their solutions, as *pepsin* and *albumen*, from the liquids in which they are dissolved in the stomach, thus retarding or stopping their digestion. Alcohol is also powerfully antiseptic. Pure alcohol is a poison. Proof spirit consists of a mixture of about equal weights of alcohol and water. When properly diluted and wisely administered, there can be no doubt that in the hands of the able physician it is a most important and valuable medicinal agent. With this knowledge the Council of

our Infirmary had no alternative but to reject the non-alcoholic-treatment-of-disease challenge recently made to them, notwithstanding the tempting donation of £1,000 with which its acceptance would have been accompanied.

Many physiologists, compelled by evidence to admit, that even the smallest quantity of alcohol as food or drink is quite unnecessary to man in a state of health, and anxious to justify its usefulness, on the ground of the universality of its use, are also compelled to admit that its use in quantities exceeding one to one-and-a-half fluid ounces per day, must be more or less injurious to the healthiest.

In all our common alcoholic beverages the alcohol is, however, very largely diluted; its physiological effects are therefore very greatly modified or greatly reduced. In my further remarks on this subject I therefore wish it to be understood that I refer not to absolute alcohol, but to alcohol of the strength we find it in the beverages to which I may be referring. I also wish it to be understood that I refer to them only in relation to their use as food or drink of every-day life. I do not speak from a medicinal or a pathological point of view.

While fully admitting that we are not even yet, after very able and diligent investigation of the subject, thoroughly informed on the physiology of the alcohols, more especially of common alcohol, we have most ample evidence of the utter fallacy of the opinions almost universally held by medical men and others of half a generation since—opinions which even at the present time are, unfortunately, not entirely discarded by many.

Beers and *wines*, and other *fermented liquors*, are used because of their alcoholic or stimulating qualities. By some they are said to be slightly nutrient, but the minute portion of nutriment they contain, even should they contain any, is contemptible as compared with their cost. A pinch or two of oatmeal in a pint of water would give a far more nutritious mixture than any ordinary wine or beer. Wines usually contain from 9 to 25 per cent of alcohol. Ordinary beers and ales contain from 3 to 14 per cent of alcohol. Lager beer only contains 2 per cent of alcohol, and is therefore one of the most harmless of alcoholic stimulants. The free use of ale or beer tends to produce fatty degeneration of the heart and great blood vessels. Brandy, whiskey, and other forms of alcoholic spirit, which cannot by any means nourish the body, tend to produce in a greatly aggravated form all the evil consequences of

excessive beer-drinking. Why they act so readily on the liver, lungs, and kidneys, has already been shown. In consequence of its influence in promoting *fatty* and other forms of *degeneration* of the tissues, alcohol has been designated "the genius of degradation" (of the tissues); and its influence is well borne out by the long history of tissue-degrading cases, producing brain softening, arterial break-down, &c., of publicans and others whose occupations most lead them into its excessive use. In order to give you some insight into the *modus operandi* of alcohol in the doing of this mischievous work, I proceed to offer, with the aid of the diagrams before you, a brief description of the microscopic blood-vessels, and of its action upon them.

The health and efficiency both of the body as a whole and of each of its constituent organs in particular, depend mainly on the the perfection with which they are nourished. The nourishing or repairing and building up of the body depends chiefly on two things—1st, a due supply of pure blood, 2nd, the condition or *tone* of the microscopic blood-vessels, the minute arterioles and the capillaries. Alcohol tends to render the former impure, and to paralyse the latter, so as to render them incapable of performing their functions properly. By *tone* is meant a peculiar form of contractile power of the blood-vessels, especially of the minute arteries (the arterioles); this quality depends on the muscular fibre built into their walls. If these arterioles lose their healthy contractile power, their diameters become abnormally large; they then allow too much blood to enter the capillaries, which thus become unduly stretched and congested, and incapable of affording properly prepared pabulum to the adjacent tissues, which suffer accordingly. The more active the organ, the greater its vital importance, the more abundantly it is supplied with capillaries. The *capillaries* are minute blood-vessels whose diameter varies from $\frac{1}{3000}$ to $\frac{1}{2000}$ of an inch in diameter. The *tonicity* of the walls of the arterioles is largely derived from the nerve stimulus conveyed to them by certain nerves termed vasa-motor nerves. Even a comparatively small quantity of alcohol partially paralyses these nerves, thus causing the walls of the arterioles to become flaccid and relaxed. Medicines which produce the opposite effect to this are termed *tonics*. The redness of blushing is due to temporary paralysis of this kind; the redness of a grog-blossomed nose is due to a more permanent nerve paralysis of the same kind. The redness of the face and neck after or during wine and spirit-

drinking also illustrates this same form of vasa-motor nerve paralysis. What we thus see in the face really takes place more or less all through the system when under the influence of wine or spirit-drinking.*

There is a general concensus of opinion among writers on the social aspects of the temperance question, to the effect that the use of beer, wines, and even spirits, especially among the working classes, is largely due to bad and insipid cooking, and to the want of piquancy and flavour of our ordinary drinks. Water, or even toast and water, certainly no one will venture to say, will fillip a jaded appetite into the enjoyment of a badly-cooked and insipid dinner, while to the conventionally-trained taste, the gustatory fillip afforded by a glass of what is termed "good fresh ale or beer," is undoubted. The general physiological action of a "glass of ale," may be, and I fully believe is, bad, but that it, to a certain extent, has power to flog the appetite of those who have been trained (in general against their original nature) to like it, is undoubted. But temperance advocates, who certainly are not below the general average of their fellows in intelligence and foresight, are already aware of these facts, and by the diffusion of general knowledge, the promotion of cookery classes, and encouraging the teaching of cookery to the advanced pupils, and the pupil teachers of our girls' elementary schools, are earnestly endeavouring to remove this source of discomfort and intemperance.

Undoubtedly the practice of taking large draughts of cold beer or other liquid, so usual at the commencement of an important meal, especially when the body is jaded or the digestive capacity is but feeble, must be injurious in the long run, notwithstanding the resuscitation of appetite.

The immediate influence of effective, wholesome flavour is to

*At a somewhat recent meeting of the medical profession held in Manchester, to discuss the "collective investigation of disease," a distinguished physician, a scientific man of whom Manchester is proud, after recapitulating the virtues, the energies and the vices common to the alcohol-drinking nations, wound up in the following words of doubt or warning:—"It would not be altogether a satisfactory consummation to find, after banishing alcohol from our midst, that the nation had become somewhat poorer in manliness and intellectual worth." Surely this is but a repetition of the misgivings of the parson, who a century or less ago, argued against the abolition of the practice of cock-fighting, inasmuch as under it England had grown up prosperous and glorious.

call the nerves of taste, and in most cases, also of smell into activity. These wake up the brain and spinal cord, which immediately as it were flood the stomach and the digestive organs with a rush of nerve power, which at once brings them into work on piece-work and not on day-work principles. My artisan friends will I have no doubt understand the difference implied in this illustration.

Numerous attempts have, at various times, been made to invent and add, as it were, to the list of inviting temperance drinks—that is, to make them more piquant, and therefore, more inviting. Some of these attempts it must be admitted have not been altogether honest. Some of the so-called temperance drinks have undoubtedly contained more alcohol than many alcoholic drinks already in use.

I have been informed that it is supposed, and that not without very strong reasons, that one popular form of temperance drink, especially noted for its power to warm up the stomach and the skin, sometimes at least has owed its power, in part, to the influence of nitrite of amyl, one of the most injurious forms of alcohol compound.

Dr. B. W. Richardson, writing in his most valuable "Lectures on Total Abstinence," on the subject of temperance drinks asks—

> "Is there nothing that will take the place of alcohol for social purposes, harmless as water, represent wine, something that will please the palate in the form of a drink? Is there nothing that will support when it is taken as a drink, and relieve fatigue and exhaustion, mental and bodily?"

In reply to these questions he refers us to the celebrated discovery of the illustrious philosopher, Dr. Priestley, who first showed us how to aërate common water with carbonic acid gas, and thus greatly increase its refreshing agency. To Dr. Priestley we thus owe our modern gasogène. He also refers us to Mr. Larmuth, of Tunbridge Wells, who, he says, has produced a series of aërated waters which vie with many wines in delicacy of flavour. He likewise refers us to Mr. Heriot, as the inventor of substitutes for ales and beers, which are most refreshing and agreeable; to Mr. Frank Wright, who has produced an unfermented wine from the juice of the finest grapes; to Messrs. Hogben, Wright, and others, who, he says, have produced syrups which are to many tastes most commendable. But he further says these do not give that false sense of relief from weariness which alcohol gives, and for which it is so dangerously prized.

Nothing, perhaps, so rapidly relieves the sense of muscular fatigue as a cup of very strong beef tea, possibly improved in this respect by a little oatmeal, or a cup of a strong infusion of Liebeg's Extract of Meat, which may also, if preferred, be similarly thickened with oatmeal. It was, I believe, the custom in London two or three years since to supply the guests at balls and other late parties just before breaking up in the small hours of early morning with basins of very strong beef tea.

Before leaving this subject, however, I should like to introduce to your attention somewhat fully the very suggestive letter, "On England's Drinks, and the Cause of Intemperance in her People," published in the *Lancet*, four or five years since, by Dr. Daniel Hooper. He says, speaking of certain out-door measures—

> "These must in time elevate the literary tastes of the masses. But the people must also drink, and what have we done to improve their tastes in this respect? Almost *nil*. The thirsty working man, or woman, or child, has to choose between very questionable water and fiery, adulterated alcoholic liquors; for ginger-beer, lemonade, and soda-water at 4d. and 6d. a bottle are beyond their reach. They ought to be able for 1d. or 2d. to get a bit of ice, a fruit-syrup, and half a pint of eau gazeuse. Why should there not be at every bar and children's party a gasogène, an ice-box, syrop de groseille, and good ginger-beer at 1½d. per bottle? As Dr. Braxton Hicks says, it is a disgrace to this country that these cool, cooling and wholesome drinks are not to be found everywhere. Indian men, who must abstain from alcohol, make ginger-tea from the root, adding Sainsby's Syrup and Tincture of Orange; or they drink ginger-lemonade-syrup with water from a gasogène; or they make a strong tincture of cloves, cinnamon, ginger, orange and lemon peel, a few drops of which, added to a tumbler of water or ginger-tea make a pleasant drink, or, in winter, with sugar and hot water, a good cordial. They also use the various fruit syrups, with ginger and orange, mixed with lemonade or eau gazeuse. Dr. Hooper says he feels certain that if these various drinks were once known and tried, the drinking tastes of the people would improve, and intemperance gradually die out."

Having thus compressed into my lecture on "Drinking" as much as time and circumstance would permit me, in relation alike to the organs, the processes and materials concerned in the same, I cannot better conclude my duty this evening than by presenting you with a brief list of some of the inconveniences and results of habitual alcohol drinking, even though the amount habitually taken never give rise to actual intoxication.

We drink to allay thirst. But thirst is a peculiar nervous condition brought about by a special condition of the whole

system. Alcohol drinking tends to bring about that condition permanently and thus to make thirst perpetual.

We have shown how alcoholic drinks tend to produce congestion of the capillaries through the whole system; congestion tends to become inflammation.

In large quantities spirits redden the interior coat of the stomach, check digestion and also produce a "chronic catarrhal condition" of the stomach, with its consequence, dyspepsia. They tend to increase the connective tissue of the glands, as the liver, kidneys, &c., but at the same time to wither up the working parts of their structure. They act on the lungs, lessening the quantity of carbonic acid they excrete, altering their molecular structure, and tend to produce chronic bronchitis and other serious diseases. They give rise to fatty degeneration of the heart, and at the same time they give it more work to do and less time to rest in. This becomes even more serious later in life, when the large blood-vessels become more rigid. They lessen the healthy chemical changes which should be produced in the blood, and thus cause *lithic acid* and other imperfectly oxidized waste products to collect in the system and give rise to gout and rheumatism. They produce ultimate permanent enlargement of the capillary vessels of the skin producing "turgescence and enlargement," entirely altering the appearance of the skin, as frequently seen in a very marked form in the face of the drunkard. It also produces or aggravates acne, eczema, and other disgusting diseases of the skin. Beer and spirit drinkers are also very liable, especially in case of slight injuries, to erysipelas.

Alcohol drinking also tends to produce congestion and inflammation of the liver, also cirrhosis (hobnailed or drunkard's liver), most painful diseases. It also tends to produce inflammation of the kidneys, Bright's disease, dropsy, and to the formation of calculi (stone in the bladder), and gravel. Alcohol, even in small quantities, diminishes the delicacy of sensitive or nerve action, and the rapidity of our impressions. It lessens our power of control over our thoughts, a result frequently mistaken for increased power of imagination. It lessens our power of resisting cold, and also the *contractility* of muscular fibre and, therefore, of muscular power in general. It produces pathological changes in the membranes and blood-vessels of the brain. It is the chief agent which fills our lunatic asylums, causing more insanity than arises from any other one source.

By setting up depraved nutrition of the brain and nervous tissue, it leads to epilepsy, paralysis, lunacy, idiocy, apoplexy and other forms of brain disease. Dr. B. W. Richardson, F.R.S., than whom no man speaks with more authority on this question, recently speaking on this subject said:—"A man who had once gone wrong and gained the craving for alcohol had no will at all; his will was entirely gone, and after that alcohol could not be prescribed for him without great danger." And now for my moral. Is it not obvious? Avoid alcohol drinking entirely and thus escape the tribe of plagues I have conjured up before your view.

THE EYE AND SEEING.

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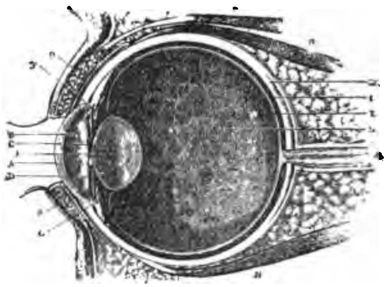
GENERAL STRUCTURE—APPENDAGES—ALBINOS—CATARACT—"PEARLS"—NORMAL SIGHT—SHORT SIGHT—LONG SIGHT—OLD SIGHT—IRREGULAR SIGHT—USE OF SPECTACLES—ACCOMMODATION—CONVERGENCE—EFFECTS OF SCHOOL LIFE ON EYESIGHT—GLAUCOMA—SQUINT: ITS PREVENTION AND CURE—CARE OF THE EYES IN INFANCY—POULTICES—TOBACCO—ALCOHOL—ACCIDENTS—COLOR-BLINDNESS—MUSCÆ-VOLITANTES—CONCLUDING REMARKS—TEST-TYPE.

THE time allotted to me will only permit a brief *resumé* of the structure of this most important "gateway of knowledge," but I hope that my remarks may induce you to study this fascinating subject for yourselves. The eyebrows, eyelids, the lachrymal apparatus, consisting of the lachrymal gland that secretes the tears, the little canals that convey these tears to the lachrymal sac and thence to the nose, are called collectively the *appendages of the eye*. The *eyebrows* play an important part in the expression of the face, and are useful in dispersing the perspiration from the forehead, and in shading the eye from excessive light. The *eyelids* are complicated in their structure, to meet the many requirements for which they are specially adapted. They are opened and closed by special muscles, and occasionally the nerve that supplies the elevator of the lid is paralysed, and the eye is rendered for the time being practically useless; at other times the nerve that supplies the muscle that closes the lid is paralysed, and the eye is consequently in danger from exposure to floating dust and other irritating influences. When the lachrymal ducts are blocked up the tears constantly run down the cheek, and in order to prevent troublesome complications, such as abscesses of the lachrymal sac, relief should be sought early. The *eyeball* is nearly spherical in shape, and placed in a commanding position in a bony socket,

lined with fluid fat. By means of an elaborate system of *muscles* (*i.e.*, bands of flesh) four straight or *recti* and two oblique muscles, an extensive range of movements is secured, thus widely differing from the *fixed* eyes of insects, which require some thousands of eyes to compensate for this free motion, *e.g.*; the house-fly is provided with 17,000 eyes, and some of the beetles with more than 25,000!



* FIG. I.—SECTION OF EYEBALL.

The outer coat of the eye is called the *sclerotic* (H fig. I.), and from its hard, fibrous structure, is the protective coat. Its transparent portion in front, the window of the eye, is called the *cornea* (A), which fits in like a watch-glass to its case; the middle coat, the *choroid* (I) is the vascular coat, and is largely composed of pigment, which absorbs the superabundant rays of light; and the inner coat, the *retina* (K) is the nervous membrane, which is really an expansion of the optic nerve (M). Immediately behind the cornea is the *anterior chamber* (B) filled with a watery fluid, the *aqueous humour*, which intervenes between the cornea and the curtain or "internal eyelid," the *iris* (D), the circular aperture in the centre of which is called the *pupil* (C). Behind the pupil is the *crystalline lens* (E). Still further back, occupying the posterior four-fifths of the eyeball, is the jelly-like transparent *vitreous humour* (L). The cornea, which occupies only a small space in front, is, however, a most important structure, as any damage done to it interferes with the passage of light to the retina; any ulcerations or inflammations of the cornea should be immediately attended to for fear of the resulting opacities or scars, or, as they are called in popular language, "pearls," and sometimes, but very erroneously, "cataracts."

* For the blocks used in the illustrations of this Lecture I am indebted to Mr. G. E. Davis, F.C.S., &c., Editor of the *Microscopical News*.—A. E. J.

The *iris* (Fig. 2) is composed of an inner layer of circular fibres, and an outer layer of radiating fibres, which enable it to

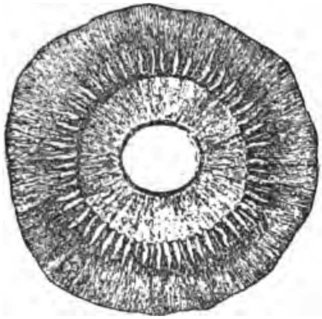


FIG. 2.—IRIS.

regulate the amount of light admitted into the eye. When the eye is shaded the pupil expands, and when, on the contrary, it is exposed to strong light, it contracts. We are all familiar with the unpleasant sensation of attempting to look at a strong light immediately on awaking. Some drugs applied to the eye, or taken internally in large doses, dilate the pupil, *e.g.*, belladonna and duboisia, and others, such as the Calabar bean, opium, and tobacco contract it to a pin-point. Heavy smokers often have this pin-point pupil, and it is to be considered a warning to lessen the amount consumed. The colour of the eye is really the colour of the iris—black, blue, hazel, &c., according to the quantity of pigment deposited in its stroma. When the pigment is absent from it, and from other parts of the body, we have a most peculiar appearance, seen in *albinos*, who have a snow white hair, fair skin, and pink eyes most sensitive to light on account of the large quantity admitted and the absence of pigment.

The *crystalline lens* (K) in the normal condition is transparent, and when from injury or senile changes it becomes opaque, the disease called *cataract* is formed, and when we speak of removing a cataract by operation we mean that the whole lens is extracted. It is a common notion that cataract is a growth in the eye, but you will from these remarks be able to understand its true nature. The *retina* as seen by illumination of the eye with an instrument

called the ophthalmoscope presents the appearance shown in the diagram (Fig. 3), where you perceive the optic nerve, with the

FIG. 3.—RETINA.

arteries and veins radiating on its surface, and on the outer side of the nerve, and exactly in the centre of the posterior part of the retina is the yellow spot, which is the part with which we see most distinctly. The minute structure is well shown in Fig. 4 to

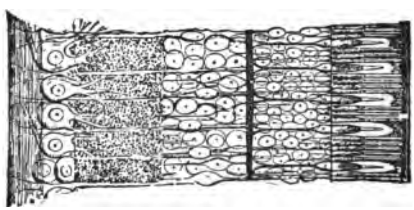


FIG. 4.—SECTION OF RETINA.

consist of a limiting membrane, a layer of nerve fibres and nerve cells, several granular layers, and a layer of rods and bones, which play an important part in the process of seeing. When the impressions have been made on the retina, the sensations are conducted by the optic nerve to the brain. In order to explain the physiology of vision, and how images are formed on the retina,

I have brought here to-night a very ingenious instrument called Jung's artificial eye, kindly lent me by Professor Gamgee. It consists of a box or trough with its inner surface painted black, and the outer surface is of plain glass, so as to enable you to watch the experiments. In front a convex lens is fixed, to represent the cornea, and immediately behind a small diaphragm to represent the iris. A moveable convex lens is now placed in, of the same focal power as the crystalline lens, and another moveable opaque screen to represent the retina. Having filled the box with distilled water, and coloured it with a little eosine or fluorescine (aniline series), I throw a *parallel* beam of light from the lantern into it, and you will see, most beautifully demonstrated, how the parallel rays are bent or refracted by the representations of the cornea and lens, and brought to a point (focus) on the retina. By placing this cross a little in front of the cornea a small inverted image of it is formed on the retina. The relative positions of the cornea and retina at present are arranged to represent a *normal* or *emmetropic eye*, in which the antero-posterior axis is of exactly the correct length, and the rays of light are properly focussed. I will now move the retina further back, and make the antero-posterior axis *too long*, to represent a *myopic* or *short-sighted* eye, and you will see that the beam of light is not focussed at all, only a diffused patch falls on the screen. A *concave* lens, as you know, causes rays of light to diverge. If I select one of the correct strength, and place it in front of the cornea, the beam is instantly focussed, and a distinct image is obtained, and this experiment enables you to understand the use of concave glasses in myopia. If I now move the retina forwards and make the antero-posterior axis *too short*, we have the reverse condition, called *hypermetropic* or long-sightedness. The rays of light are focussed *behind* the screen, and on the screen itself we have only a patch of diffused rays and a blurred image. A *convex* lens causes the rays of light to converge, and consequently, if I place a convex lens of the proper focal power in front of the cornea the beam is again focussed. This experiment shows very clearly the use of convex spectacles in long-sightedness. When we look at a distant object, and then suddenly at a near one, we are conscious of some focal change in the eye, and we can satisfy ourselves of the existence of this power of focussing, called *accommodation*, by a very simple experiment. If in a room we look at the window-sash through a thin veil in front of our eyes, we can only see one of

these objects clearly, and at the same time, when the window-sash is seen distinctly, we are scarcely conscious of the net, and *vice versa*. This change in focus is brought about by the action of a delicate band called the ciliary muscle, through the influence of which the anterior surface of the lens is made more convex.

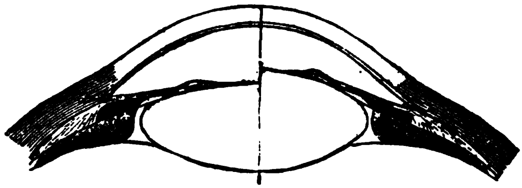


FIG. 5.—PLATE OF ACCOMMODATION.

This is well shown in the accompanying diagram, in which the left half represents the lens in its state of rest, and the right half the lens made more convex during accommodation for near objects. In cases of moderate hypermetropia this focussing power of the lens enables people to read for a short time distinctly, but when the little ciliary muscle gets tired the lens falls back into its normal state, and the lines and letters get muddled and indistinct. The correction of this defect can be easily accomplished by wearing the proper convex spectacles, and yet it is strange how many people strain and fatigue their eyes unnecessarily, and so often induce serious diseases of the eye. About the age of forty-five this power of accommodation begins to fail, the lens becomes hard, and the ciliary muscle less active, and there is consequently great difficulty in seeing near print—the book is held at a further distance, &c. This is the condition called *presbyopia* or *old-sightedness*, and here again convex glasses exactly equivalent to this failure of accommodation are required. *Astigmatism* or irregular sightedness is the name given to that condition where the curvatures of the cornea are irregular, and one meridian has a different focus from the other, *e.g.*, a person suffering from this defect might be able to see the hands of a clock quite distinctly while in a vertical position, as they would be at half-past twelve, but could not see them at all when in a horizontal position, as at a quarter to three. The proper adaptation of *cylindrical* glasses will correct this condition. The origin of many violent headaches can be undoubtedly traced to the optical defects

enumerated, especially astigmatism. The prejudice against the use of spectacles in proper cases is most unwarrantable, as they are not only useful but essential to good eyesight. Spectacles are especially of importance in short-sightedness, for, apart from the contracted world of the myopic and the loss of the influences of surrounding objects on his education, and the pleasures of scenery denied to every short-sighted individual, this condition is liable to be complicated with serious diseases. In youth the tissues of the body are not properly developed, and therefore the greatest care should be taken to avoid all deterring influences. You are all only too familiar with *rickets*—an affection caused by the bending of the bones of the legs from the absence of lime constituents, and the foolish habit of allowing children to walk too soon. In a similar way, too great a pressure is brought to bear on the eyes of children of this cram-educational age. In the effort to see near objects the eyeball is compressed, and being yet soft, it bulges at the posterior part, and the sclerotic often gives way, and when this firm protective coat gives way the choroid and retina are also apt to yield. The latter is most disastrous to sight. To mention an illustrative case: I saw recently a young girl, aged eleven, whose mother informed me that up to two years ago she had not noticed anything particularly wrong with the sight; the child had gone to school and worked hard, and as her sight was failing markedly and progressively, she was brought for examination, which showed that the whole of the retina had given way and permanent blindness resulted. This is, I grant, an extreme, but by no means a unique case, and I mention it to impress on you the necessity of early attention to this defect. The influence of school life in producing myopia has been well considered by German authorities, and also in Russia and America, and to a slight extent in this country. Dr. Cohn, of Breslau, who was among the first to study the subject, examined the eyes of over 10,000 school children in that district. In elementary schools 6·7 per cent were short-sighted; in intermediate schools, 10·3 per cent; in high schools, 19·7 per cent; and in gymnasia, 26·2 per cent; and in the University of Breslan, 64 per cent were myopic; at Magdeburg, 75 per cent; at Erlangen, 80 per cent; and in many classes at Heidelberg, 100 per cent! The percentage gradually increases from the lower to the higher. Bad light, bad type, school furniture constructed on wrong principles, have been proved to increase the development of myopia. It is therefore incumbent on us to

demand from school boards and oth rs that are entrusted with the management of education to see that everything is done to lessen these evils. I am an advocate of the best education for all classes, but that education should not be given under conditions detrimental to any part of our physical frame. I may just mention that myopia is hereditary—a fact to be remembered by those of my audience that look forward to matrimonial alliances. It would be well for parents and schoolmasters to test the eyesight of children periodically, and wherever defects are noticed to get them remedied without delay. A convenient test-type is appended.

Glaucoma.—This is a disease which should be mentioned here, as it is a very destructive one to the eye. In the earlier stages the patient requires the glasses constantly changed, there is a feeling of fulness in the eye, and rings and halos are noticed round the gaslight or candle. In some acute attacks there is violent neuralgic pain, and the sight is quickly destroyed. The increased tension or pressure of the contents of the eye destroys the power of seeing completely. An *early* operation is the only hope in this affection.

Squint.—The most common form is internal squint, generally caused by the constant effort to see near objects. In cases of hypermetropia (long sight), along with the increased effort to focus, there is an increased effort to converge the eyes, and at last one eye turns in permanently. Squint is generally noticed in children from two to four years of age, when the eyes begin to be used to observe minute objects. The effect of imitation in the production of squint has been greatly over-estimated. Besides being a deformity which militates against the chances of success in many walks of life, *the sight in the squinting eye soon begins to fail* from non-use, and ultimately it may fail entirely. In the earlier stages, arresting the accommodation and correcting the optical defect by spectacles may cure it; if not, it should be rectified by a slight operation, consisting in the division of the tendon of the internal muscle which pulls the eye in. The operation is free from risk, and, as a rule, successful. The idea that the eye is taken out and put back again is entirely wrong, and often deters people from attending to their eyes in time.

A great deal of injury to sight is produced through the ignorance of the value of good light, and insufficient illumination and proper ventilation. Daylight is by far the best of all lights, and it should fall on our work from the left

side, if possible. It is very injurious to face strong light, and grave results have occurred from staring at the sun, electric light, &c. It is a misfortune that many of our clerks and workmen are compelled to work in badly-ventilated rooms, and with artificial light; and I wish the spirit of trade unionism and co-operation could be diverted from some channels which seem to me mistaken to the consideration of questions affecting the health of body and mind. Much could be done by a unanimous protest against the unhealthy condition of warehouses and workshops. Where gas has to be used, a steady brilliant burner should be procured. Nothing is worse than a flickering light. In reading, the eye should be rested occasionally, and not used too long at a time. Reading in front of the fire, in bed, in railway carriages and trams especially, if the print is small, is highly injurious to sight. Stooping of the head should be studiously avoided, as there is a constant rush of blood to the head and eyes, and also interference with the free action of the lungs and other important organs, and in school children the spine is very liable to be distorted by irregular postures.

Care of the eyes in infancy.—A large percentage of the blindness existing is due to eye affections occurring during the first few weeks of life. Wherever there is any matter escaping from a baby's' eyes it should be kept constantly clean, with clean and soft linen cloths and cold water. *Medical advice should be sought without any delay. Poultices should never be used to the eye.* It seems that people generally poultice the eye with tea-leaves, bread, linseed, &c., as the first remedy, and nothing worse could be done in most cases. Many an eye has been lost through this foolish practice. The Sanitary Association has published an excellent pamphlet on this subject, and it should be circulated far and wide.

Tobacco.—The fumes of tobacco often keep up a certain amount of irritation of the white of the eye (conjunctive). Smoking in quantities of half-an-ounce a day and upwards is undoubtedly injurious, and leads to very defective sight. Great moderation, and, better still, abstinence, is the only remedy.

Alcohol.—I must refer you to my remarks in a lecture on "Diseases Produced by Drink" for details. The sight is often greatly damaged by excessive drinking.

In "colds" of the eye, if a little cold water does not check it, it is better to seek advice. Avoid poultices, and also "sugar of lead" lotions, as crusts of lead are often deposited on the eye. This is a favourite remedy with amateurs, and it is surprising

that such an important organ as the eye should be entrusted to the ignorant quack. The teaching of physiology in schools, and the general advancement of education, alone can rectify these matters. A minute speck of dirt or dust under the eyelid gives rise to great pain and irritation, the tears sometimes wash it away; if not, the eyelid must be turned and the particle wiped away with a soft rag. When *lime* or *acids* get into the eye, at once use cold water and put in a drop of olive or castor oil, and lose no time in consulting a doctor.

Accidents of a serious nature are often caused in a simple way, *e.g.*, using a fork to undo a shoe-lash; allowing a child to use a knife or fork; children playing, with pen-holders behind their ears; puff and dart, tip-cat, &c., &c. I merely mention them here hoping that those that hear me may co-operate in the good work of preventing such sad accidents. Shuttle accidents are numerous in a district like this, and it is a shame that the use of efficient guards are not made compulsory. When one eye is destroyed, it is very liable to affect the other by sympathy. I can only just refer to

Color-blindness.—Some are red-blind, and this form is called Daltonism, from our distinguished fellow-townsman, who was

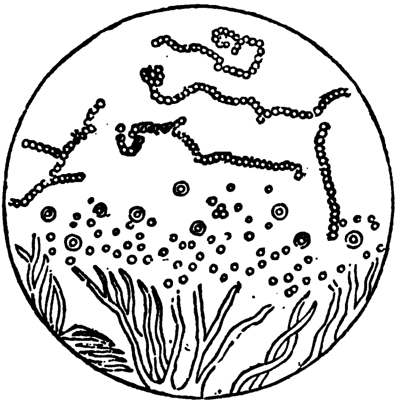


FIG. 6.

himself red-blind, and the first to describe this affection. Others are green-blind, or violet blind. It is very rarely that we meet

with any one totally color-blind. When we think that the engine-driver and the signalman have our lives in their keeping, and that we may be hurled to destruction through their mistaking a red signal, which is the one for danger, for green, we ought to insist on our railway companies compelling all their employés to be rigidly tested as to color-vision. Sailors, also, should be tested. It is estimated that about 4 per cent of males are color-blind, and one-fifth per cent. of females.

Muscæ Volitantes (Fig. 6).—Some people are annoyed by little bodies of various shapes, constantly floating before their eyes. They are caused by shadows thrown on the retina by little round opacities in the jelly-like vitreous, which are projected outwards, and appear to be floating in the air. They are generally of no consequence, and not indicative of disease.

I have already detained you too long, and a great deal of useful information respecting the eye and sight must be left unsaid. I hope, however, my remarks have been suggestive, and that, as a result of what you have heard, you will be more careful of your own sight, and more desirous of helping others to preserve the inestimable function of vision, the loss of which Milton describes in his own case in this sad strain—

> "Not to me returns
> Day, or the sweet approach of ev'n or morn;
> Or sight of vernal bloom, or summer's rose:
> Or flocks, or herds, or human face divine;
> But cloud instead, and ever-during dark
> Surrounds me, from the cheerful ways of men
> Cut off, and for the book of knowledge fair
> Presented with an universal blank."

[For test-type referred to, see next page.]

N P R T V Z B D F H

S U Y A C E G L N P R T

In good light the upper type should be read by each eye separately at a distance of 20 feet, and the lower type at 15 feet.

EATING.

By JOHN PRIESTLEY, Esq., M.R.C.S.,

ASSISTANT PHYSICIAN TO THE HOSPITAL FOR CONSUMPTION AND DISEASES OF THE THROAT; LATE LECTURER ON PHYSIOLOGY AT THE OWENS COLLEGE.

IT will be evident to such as have perused the list of subjects for this year's course of Health Lectures that the object of those who have organized the course is to furnish their readers with a series of lectures which shall supply a physiological foundation upon which the various hygienic laws may be erected, rather than to illustrate those hygienic laws themselves. In accordance, then, with the expressed wishes of the Committee, this lecture will be mainly physiological.

I apprehend that what is commonly understood by the term eating is the mastication and swallowing of solid food. We talk of eating meat and bread, but of drinking milk or ale—

> "I cannot eat but little meat,
> My stomach is not good;
> But sure, I think, that I can drink
> With him that wears a hood."

This narrow definition will not suit our purpose. By eating we shall understand the introduction of food into the digestive apparatus, in order that it may be subjected to the process of digestion, whether that food be in the liquid form or in the solid form. Digestion is the preparation of food for absorption into the system; and the materials of nature are of no value as food except as they yield themselves to this preparatory process. When once within the system the matters of food serve to build up the body, to renew the strength, and to restore the organism to its original state of efficiency.

Restoration, however objectionable in the case of crumbling cathedrals, is daily necessary in the case of our continually decaying frames; and if it be neglected, the organism calls for it in an imperious fashion, through the sensations of hunger and thirst. Hunger is popularly referred to the stomach, and thirst to the mouth and throat; but in reality it is the whole body which suffers and gives rise to the sensation in both cases, as we know from the fact that after certain injuries, the stomach may be full of nutritious food properly digesting, and yet the sensation of hunger may be intense.

Hunger leads us to eat; *eating* starts the process of digestion; *digestion* prepares the food to pass into the system, and when there it becomes *assimilated*, or made like the various constituents of which the body is built up; and, according to the dearth of assimilative material, do we experience the sensation of hunger; this is the "vicious circle," in which we are compelled to pass our existence.

Before we can understand the particular subjects of eating and digestion, we must have clear notions of what we mean by food, and I know of no better way of arriving at such knowledge than by taking some perfect food and analysing it. Such a perfect food we have in milk, which is well known to be sufficient for the nourishment of the young of all mammalian animals. It has, further, been again and again demonstrated that milk is sufficient by itself to support healthy life in adult persons. If you place a drop of milk under the microscope, and examine it under a power of three or four hundred diameters, the opaque fluid shows itself to consist of a clear menstruum, in which vast numbers of fine globules are floating; it is to the presence of these innumerable globules that milk owes its characteristic whiteness. Each globule is a particle of oil coated with a thin pellicle or skin of albuminous matter called *casein*. In fact, a liquid resembling milk in the closest manner may be prepared by dissolving a little unboiled white of egg in dilute solution of caustic soda, and shaking up with it some olive oil; such a fluid not only resembles milk to the naked eye, but the resemblance is remarkably close, also, under the microscope What, now, are the constituents of milk? We do not need to repair to a chemical laboratory for an answer to this question, for the analysis of milk is daily performed for us in a variety of dairy processes. I need hardly remind you of the method of butter making; rich milk is violently agitated until the

thin pellicles enveloping the fat globules are broken, whereupon the fat escapes and forms large masses which float on the surface. This operation may be imitated in miniature by squeezing together the two pieces of thin glass which contain between them a drop of milk for microscopic examination. The pellicles may thus be ruptured before our very eyes, and the fat may be seen to form masses of butter. One constituent of milk, therefore, is a *Fat* or oil, called butter. If another specimen of milk be treated by the addition of a dilute acid, such as vinegar; or, better still, if the peculiar ferment of *rennet* be added to it, the milk *curdles*, that is to say, a copious flaky precipitate is thrown down, leaving a more or less clear fluid known as *whey*. The curds are found to consist of much albuminous matter, allied to, although not the same as, the white of egg, together with very many of the fatty particles of milk. It is the albuminous matter which, being dissolved in fresh milk, is thrown into an insoluble state by the addition of the re-agents named, and which, on suddenly assuming the solid form, entangles the fat and carries it down. By appropriate means, the fat can be dissolved, and the rest of the curd will then be left as *Albuminous matter*, containing that most characteristic element of animal life, *nitrogen*.

If the whey left after the separation of the fat and albuminous matter be allowed to evaporate slowly and with proper precautions, a hard, crystalline, slightly sweet substance may be obtained, which is known as *sugar of milk*. This is closely allied to that sweet incrustation sometimes seen on the skins of old raisins, and more distantly allied to cane sugar and the great group of the starches. The whole group is called *Carbo-hydrates* by the chemist.

The remaining constituents of the whey are certain *Inorganic salts*, of which common table salt is one; and, finally, *Water*, the vehicle in which all the other constituents are carried. The result of these analytical processes of the dairy is to show us that the elements of the perfect food, milk, and therefore, by implication, the necessary elements of any perfect diet, fall into five groups, namely—

1. Nitrogenous albuminous matters.
2. Fats, or hydro-carbons.
3. Carbo-hydrates, such as starch and sugar.
4. Inorganic salts.
5. Water.

No food, or combination of foods, is perfect or all-sufficing which does not contain representatives of these five classes. Not only must they be present, but they must exist in certain defined proportions. In milk the proportions are shown in the following table:—

Albuminous matter	4·0
Hydro-carbon	3·7
Carbo-hydrate	4·8
Inorganic salts	0·7
Water	86·8
	100·0

It is, of course, not necessary that all the elements should be found in just these proportions in the same article of diet. In fact, one of the objects of cooking (and one of the most important objects of it) is the judicious assorting and proportioning of the different classes of food-stuffs to make up a perfect meal. I do not mean to say that this is consciously done by the majority of cooks; but it is unconsciously performed by even the most ignorant, and purposely aimed at by the skilful and intelligent. Who does not know that, as in a proverb, beans go with bacon, and fish with melted butter, bread with cheese, and milk with rice and similar starchy stuffs? But it is not every cook that could explain the underlying physiological reasons why these particular unions have gained such general approval. When we once understand that a perfect diet must include not only certain elements, but these elements in certain proportions, we can see readily why beans (and we might add fish and fowl also), which are rich in albuminous matter, but devoid of fat, have come by instinct to be best enjoyed with butter or fat bacon; why the highly albuminous milk goes naturally with the lowly albuminous rice; and why cheese containing much albuminous matter is naturally associated with starchy bread and fatty butter.

As to the source of our supply of the different food-stuffs, no candid observer will now deny that they may be obtained by judicious selection equally well from either the animal or the vegetable kingdom. The question of advantage as between an animal and vegetable diet is one to be settled solely by considerations of economy and convenience; all that the physiologist can say is, that if you are careful and intelligent in the selection and association of the necessary food-stuffs, and if you are as judicious

in the cooking of them, so as to give the digestive juices an equal chance of acting in the two cases, you may thrive as well on a vegetable diet as on an animal diet. Let me explain more fully what I mean. A vegetarian diet is likely to fail and prove unwholesome in many cases owing to the compactness and hardness of the vegetable tissues, in consequence of which the digestive juices are unable to penetrate into them and reduce them to a form fit for absorption. If, however, by skilful cooking these qualities are mitigated, then there seems to be no reason why vegetable albuminous matter and vegetable fats should not be as useful to the organism as those derived from animals. The argument in favour of an animal diet, which has been drawn from the conformation of the teeth and the length of the alimentary canal, seems to be as little worth considering as the argument against animal food, which has been found in the unproved statement that the eating of flesh renders a man ferocious.

From whatever source derived, the daily diet of an average man doing average work should include the following:—

	oz.
Albuminous matter	$4\frac{1}{2}$
Hydro-carbons	3
Carbo-hydrates	$14\frac{1}{4}$
Inorganic salts	1
	$22\frac{3}{4}$

These numbers refer to absolutely dry food-stuffs, and not to meat and bread, as they are purchased in the shops. Such solid food, so-called, contains very much water that may be driven off by evaporation. Beef, for instance, holds no less than 75 per cent of water; bread, about 40 per cent; dry peas, about 15 per cent; and cabbage, 91 per cent. Cabbages, and other similar vegetables, along with fruit, may indeed be regarded as a convenient means of introducing water into the system, so much of this element do they contain. The above numbers, therefore, may be taken to represent about 50-60 oz. of so-called solid food. Besides this, the average man requires from 50 to 80 oz. of water in the liquid form.

provided with layers of muscles, by the contraction of which the contents of the tube may be squeezed, rubbed together, and pushed along from one end to the other. The lining membrane of the

FIG. 1.

tube contains innumerable glands which emit juices in the same manner as the sweat glands pour out sweat on the surface of the body.

The digestive apparatus, although apparently extremely compli-

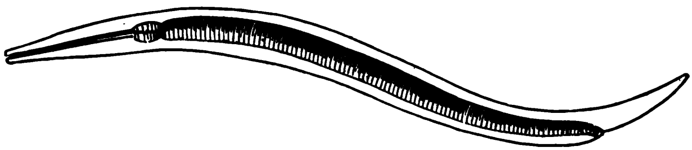


FIG. 2.

cated, is essentially as simple in man as it is in such an animal as is represented in Figure 2. It is, in fact, a tube passing through the body, the lining of which is continuous at both ends with the skin covering the surface of the body. Now, it is clear that no

substance merely touching the outer surface of the skin can be considered to be *within* the body till it has penetrated the skin. Similarly nothing touching the walls of the alimentary tunnel or tube can be said to be *within* the body until it has penetrated the skin-like membrane lining the tube. For example, there are tribes of men in tropical Africa, and in tropical America, who, by habit, eat clay. The custom is not unknown, at least during states of famine, in various parts of Europe. The clay has been repeatedly analysed, and found to contain nothing, or a mere trace of something, capable of supplying nourishment to the body. The great bulk of the clay passes unchanged through the alimentary canal. Although eaten and swallowed, it in reality never enters the body in the sense of penetrating its boundary-surface. It remains as much *outside* the body as if it were held in the hand, and yet it has been subjected to the operation of the digestive apparatus. In the same sense a piece of meat or a morsel of bread, even when in the stomach, is not within the body until it has been made to pass through the membranous lining of the digestive tube. In short, the operation of digestion, or the preparation of food for its introduction within the body, is to be classed with that other external preparation of food, viz., cooking, rather than with the true internal operations, such as assimilation, oxidation, &c., which overtake the food-stuffs in the organism.

It is not every food-stuff entering the mouth that stands in need of preparation before it can pass into the system. Water, and many salts soluble in water, grape sugar and sugar of milk, which are also soluble in water, may pass at once through the thin walls of the stomach and intestines. But the more important elements of food, if one may so call them, when all are indispensable, must undergo some change of constitution before they can accomplish the same passage. Thus, starch and cane sugar must be converted into a body resembling grape sugar, albumen must enter into a soluble and diffusible modification, while fat must be divided into extremely fine particles.

The various steps by which these ends are attained, forming the total process of digestion, although they seem at first sight very complicated, are essentially but of two kinds. They either (1) serve to mix up the food-stuffs with the juices; or (2), they are concerned in the action of the juices upon the elements of food. The first class of operations are performed by various muscular movements of the jaws, the stomach, and the intestines; the

second class of operations depend upon the peculiar constitution of the digestive juices. These fluids comprise the following :—

(1.) *Mixed Saliva.*—This is a clear viscid fluid, having an alkaline reaction, and is generally frothy from the entanglement of air bubbles. It is formed of the secretions of innumerable small glands, called mucous, buried in the skin of the mouth, together with the secretion of three pairs of salivary glands proper; one pair pour their secretion through ducts, one on each side, which may be felt by the tongue when it is thrust into the cheek opposite the upper molar teeth; the other two pairs open by pores on two small papillæ, which may be seen on the floor of the mouth when the top of the tongue is turned forcibly backwards. The constituent of primary importance in saliva is a ferment called *ptyalin.*

(2.) *Gastric Juice.* –This is a clear straw-coloured acid fluid, which has many times been obtained fresh for examination by means of accidental or artificial openings made through the walls of the body into the stomach. It contains a ferment called *pepsin*, and free hydrochloric acid. An artificial gastric juice may readily be prepared from the lining membrane of the stomach of a recently killed animal, such as the pig, by dissolving it in some appropriate fluid. Such an artificial juice may be made to perform the offices of the genuine fluid in the preparation of food for absorption.

(3.) *Bile.*—The bile is a highly-coloured, slightly alkaline fluid, bitter to the taste, and viscid. It is red or yellow in man, but dark green in herbivorous animals, such as the sheep. It differs from the juices hitherto described in containing no ferment.

(4.) *Pancreatic Juice.*—This is a clear viscid fluid of strongly alkaline reaction, secreted by the pancreas or sweetbread. It is the juice of most importance in the processes of digestion, inasmuch as it contains ferments which enable it to perform the work both of the salivary juice and of the gastric juice. An artificial pancreatic fluid may be prepared from the sweetbread of a recently killed animal in the manner described in the case of the stomach. It is sold under the name of Liquor Pancreaticus, and is prepared on a large scale by Messrs. Mottershead, the eminent chemists of this city.

(5.) *Intestinal Juice.*—This is the secretion of the glands situated in the lining membrane of the small and large intestines. It is a straw-coloured, limpid fluid, the constituents and properties of which are still exceedingly obscure.

It will be observed that the most remarkable constituents of the digestive juices are certain bodies which have been spoken of as "ferments." They are so-called because in many of their properties they resemble yeast, which induces fermentation in the making of beer. They have the power of inducing changes in the composition of certain complex organic bodies without themselves taking any share in the construction of the resulting substances. Let me explain what I mean. If I take a solution of sugar of lead in water, and add to it some oil of vitriol or sulphuric acid, a white solid substance is thrown down. The sulphuric acid has induced a change in the solution of lead, but on inquiry it appears that the acid has united with part of the matter in solution, and has shared in the construction of the resulting substance. In every part of the new substance formed a definite proportion of acid has become incorporated. When a small portion of yeast is introduced into a solution of sugar, under proper conditions of temperature, a change takes place, bubbles of carbonic acid gas escape, and the solution is found to contain a new body, alcohol. The sugary solution has been induced to split up into alcohol and carbonic acid under the influence of the yeast, but the yeast takes no share in the construction of either of the resulting bodies. Similarly, if starch paste be treated with a solution of ptyalin, or with a few drops of mixed saliva collected in the mouth, the starch becomes converted into a body resembling grape-sugar, a substance in the structure of which the ptyalin takes no material part. The insoluble starch, which has no chance of ever passing through the boundary membranes of the body, is converted into a soluble sugar, which readily soaks through the delicate membrane of the intestines into the fine bloodvessels beyond. The same change might have been induced in starch by means of Liquor Pancreaticus, prepared from the sweetbread. An analogous change is wrought in the constitution of albuminous matters by the influence of the ferments of the pancreas and the gastric juice. It is well known that solutions of ordinary albuminous material are incapable of penetrating through animal membranes. If I took some unboiled white of egg, and shook it up in water, and then placed the solution in a parchment bag, which was kept floating in a large bowl of water, none of the albuminous matter would penetrate through the substance of the parchment. If, before placing the albuminous solution in the bag, I had subjected it for some time to the action of gastric juice or pancreatic juice, we should

find in the course of a few hours abundant indications that the albuminous matter had escaped through the parchment into the surrounding water. In other words, the effect of these ferments is to convert indiffusible albuminous matters into albuminous matter capable of diffusing through animal membranes. This new form of albuminous matter is known as *peptone*.

It is by the aid of the ferments of the saliva, the gastric juice, and the pancreatic juice that starch and albumen are converted into other forms of matter fitted for the use of the body. There is reason to think that cane sugar is converted, also by a ferment action, into a sugar of the same class as that derived from starch, and it is not improbable that there are fermentative changes in other food-stuffs, of which at present we know little or nothing.

The peculiarity of all these ferments is that they act only in certain favourable conditions of warmth. Saliva added to starch paste at an ice cold temperature produces no change in the starch; at the ordinary temperature of the air the change takes place very slowly; while at blood heat it proceeds with instantaneous rapidity. If saliva be boiled the ferment is utterly destroyed. What is true of the saliva is true also of the other digestive juices. Another peculiarity is the ease with which the ferments are destroyed, some by acids and some by alkalies. The salivary ferment will only act in the presence of a neutral or alkaline fluid; even the dilute acid of the gastric juice is sufficient to stop all further activity of the swallowed saliva. The gastric ferment, on the contrary, requires an acid medium in which to act. An alkaline mixture is ungenial, and destroys the gastric ferment The pancreatic juice, like the saliva, is alkaline, and acts only in alkaline solutions; acids destroy its ferments. Hence the importance of the alkaline bile in aiding in the neutralising of the acid contents of the stomach as they are poured into the intestine ready for the pancreatic ferments. What may be the meaning of these sharp alternations and quick transitions from acid to alkaline and back again in the alimentary canal, physiologists are still puzzled to say. It seems at first sight a wasteful playing at cross purposes; but we shall do well to hesitate before concluding that it is so.

It must not be thought that the digestive juices are continually being secreted in any considerable quantity. The mouth, it is true, is constantly kept moist, but a copious flow of saliva only takes place when the mouth is stimulated by contact with food, by much speaking, or sometimes by the thought of food. In the

same way the gastric juice is set aflowing by food introduced into the stomach, as well as by saliva which may be swallowed. Not only so, but, what is of greater interest, the stimulus of food in the mouth, besides causing a flow of saliva, causes also a flow of gastric juice, even before the morsel of food is swallowed. Thus there is prepared for the food a flood of the very juice needed to dissolve it in the stomach. In a similar manner the pancreatic secretion is stimulated by contact of food with the stomach long before the food has passed into the small intestines, where the pancreatic juice is usually poured out. Thus the presence of food in one portion of the alimentary canal is the signal for the secretion of the juices to which the food will be submitted in the next succeeding portion. Now, this secretion is due to the activity of the various glands that have been named—an activity which calls for a rich supply of blood to the glands during its continuance. If we could look at the salivary glands, the stomach, or the sweetbread during active digestion, we should see them red and turgid with blood, just as the muscles are full of blood when they are active, and just as the brain is red with blood when awake. A free supply of blood is necessary for the secretion of healthy juices in healthy quantity. Whatever deflects or draws off the supply of blood from the digestive glands hinders or mars the process of digestion. If we are compelled to work much with the brain, or to use the muscles freely, just after a meal, at a time when the secretion of the digestive juices is in full swing, blood is of necessity called away from the glands into the brain or the muscles, and the activity of the glands must be sadly hampered. It is therefore wise to rest long after an important meal:—

"After dinner rest a while;
After supper walk a mile."

Nor must it be hastily assumed that the second line of this time-honoured couplet involves an assumption that muscular exercise is after all not inimical to good digestion. It must rather be taken to mean that the late meal should be of so slight a nature, and entail such small digestive labour, that some blood may be spared for gentle exercise.

Having thus briefly indicated the means at the disposal of the body for the preparation of food for absorption, we may trace the tate of an ordinary meal during the five or six hours following its

introduction into the mouth. The constituent food-stuffs of such a meal are shown at a glance in the following table:—

TABLE OF FOOD-STUFFS CONTAINED IN AN ORDINARY DINNER.

	Nitrogenous Albuminous Matters.	Carbo-hydrates, such as Starch, Sugar, and their derivatives.	Hydro-carbons, or Fats.	Inorganic Salts.	Water.
Roast Beef (including the dripping)	27½%	Mere trace	15½%	3%	54%
Potatoes........................	2%	21%	⅛%	1%	74%
Bread	8%	49¼%	1½%	1¼%	40%
Butter........................	¼%	......	91%	2¾%	6%
Fruit for a Pie or Pudding ...	½%	9%	......	½%	85%
Milk	4%	4¾%	3¾%	¾%	86¾%
Ale*........................	½%	5¼%	......	¼%	89%

*Besides the above constituents, an average ale contains 5% of alcohol and certain derivatives from the hop. Alcohol might be classed with the Carbo-hydrate group, since *small* amounts of alcohol are burnt up in the body, and thus serve the purpose of a true food; *large* amounts are excreted unchanged.

Bread, meat, or vegetables are, as they pass the lips, divided into convenient morsels by the front cutting teeth; these morsels are then pounded between the flat surfaces of the molar or grinding teeth into a pulpy mass. Again and again, in perfect mastication, this mass is submitted to the grinders, being pushed in between the teeth first from one side and then from the other by the cheeks and tongue respectively. The entrance of food to the mouth starts a copious flow of juices, which are mixed up with the food during the process of trituration. At once the ferment of the saliva attacks the starchy elements of the food; and how instantaneously the change from starch to grape sugar is brought about may be shown by taking a teaspoonful of starch paste into the mouth and instantly putting it out again. Some of the starch will already be found to have been converted into grape sugar on the application of appropriate tests. The albuminous and fatty elements of food suffer no essential change in the mouth. The inorganic salts, such at least as are soluble in water, and the soluble sugary matters contained in the food, will of course become dissolved in the watery saliva.

After mastication, the food is rolled up into a ball and swallowed into the stomach, where already some gastric juice has been secreted. Morsel after morsel of food is thus passed into the stomach, and more and more of the stomach juice is poured out of the innumerable glands studding the lining membrane of the organ. The muscular walls of the stomach are soon excited to contraction; and the contents by this means are squeezed and rubbed together, and intimately mixed with the gastric juice. In course of time the whole of the contents become markedly acid, and the ferment of the saliva is destroyed. Milk that has been swallowed is speedily curdled, and the ferment of the gastric juice attacks the curd and other albuminous matters that come within its reach; they swell up in the acid fluid, and slowly dissolve to peptone. Wherever fat is contained in albuminous envelopes or meshes, as it is for instance in the globules of milk and the fat of meat, the albuminous matters are dissolved, and the fat is set free; it floats about as large oily globules. The starches which escaped conversion in the mouth remain unconverted, as starch. Cane sugar, used for sweetening, is converted into grape sugar, since, although cane sugar is freely soluble, it is only after conversion to grape-sugar that it can pass into the blood.

After an interval of time, which varies according to the ease with

which the food in the stomach is digested, and which may be from half-an-hour to three or four hours, the contents of the stomach begin to pass into the small intestines. They are at once met by the juices from the liver and the sweetbread, which have already been poured out while the food was in the stomach. The appearance of the matters issuing from the stomach leads, however, to a more copious outpouring of the secretions of these glands, and the new juices quickly usurp the place of the gastric fluid. Just as the brief reign of the salivary juice terminates when the saliva enters the stomach, so the juice which is paramount in the stomach gives place to those proper to the intestine. Under the influence of these the conversion of starch to grape sugar goes on afresh. The albuminous matters which had not time to become converted into peptones in the stomach now fall before the pancreatic ferment; they crumble to a powder and pass into the shape of soluble peptone. The fatty matter, which as yet has undergone no change, is quickly divided into minute globules by the action of the pancreatic juice and the bile. It is in fact "emulsified," or reduced to the shape it has in milk, as was explained in an experiment described in an earlier part of the lecture.

In this manner, all the materials of food are converted into forms in which they can readily pass through the walls of the alimentary canal into the neighbouring bloodvessels: digestion is over, and absorption is about to begin. With this latter process we do not propose to deal just now.

Those portions of food in their very nature indigestible, such as that peculiar yellow substance popularly known as "taxy-waxy," or the cellulose which forms so large a part of most vegetables, pass through the digestive ordeal unscathed, like the clay referred to in a former page. With these portions must be mentioned those also which escape from the body, not because they are essentially indigestible, but because they are the surplus, or excess of food which is beyond the power of the digestive apparatus to deal with. They are utterly wasted matter; they not only take no part in nourishing the body they were destined for, but they hamper by their presence the digestion of the rest of the meal, and lead to derangements of the digestive organs. The excess of food thus introduced into the stomach at the call of a pampered and over-stimulated palate is a clearly recognised cause of much dyspeptic, and worse, trouble among the well-to-do classes.

What, now, are the hygienic rules to be drawn from this brief survey of the physiology of eating and digestion? The value of deliberate eating and deliberate mastication has been often insisted upon, and must be clear to all who have followed the argument. There are no teeth in the stomach; if meat or cheese be not reduced from the form of solid lumps or cubes by the stony surfaces of the teeth in the mouth, as lumps or cubes they will probably remain in the rest of the alimentary tube, irritating the gastric and intestinal mucous membrane, and resisting the intrusion of the solvent juices to their interior. More than this, slow mastication gives ample opportunity to the salivary juice of acting upon the starches of the food; more grape sugar is ready to pass into the blood from the stomach at the beginning of the meal, and the famished organism is not called upon to wait till digestion is nearer completion before the first fruits of it are assimilated and made use of.

The desirability of resting after an important meal has been found to have strong physiological support, besides that of experience and proverbial wisdom. Heavy muscular labour, no less than concentrated mental application, draws off the blood from the digestive glands and hinders the secretion of the juices. Bathing, whether hot or cold, has the same effect. None of these things, therefore, should be practised after a meal which taxes the digestive powers. The rapidity and stress of modern life make it almost impossible to regulate our hours of work in the daytime so as to leave a fair interval for digestion. But why should we not regulate our meals to secure the same end? Why should we not take our important meals at a time when we can have the necessary leisure? Let those who have to be at their work by nine o'clock in the morning, and can be at home for a meal not later than six or half-past in the evening, adopt some such routine as this:—Take a thoroughly good and solid breakfast at 7-30 or 8 a.m., a meal approaching in consistency a dinner, and not a mere cup of coffee with a slice of toast. Between twelve and one at noon have a luncheon, light indeed, but not unsubstantial; not two small sandwiches preserved in a tin case since breakfast time, but a little fish, or a little bread with a morsel of cheese and a couple of glasses of milk; or, best of all, perhaps, some boiled bread and milk, or milk and oatmeal porridge, such as may be obtained in one or two restaurants in this city at any hour during the middle of the day. Such a meal will entail no sense of drowsi-

ness when work is resumed half an hour afterwards. At 6 p.m. (earlier, if it be possible) have dinner. If the luncheon has not been too slight, there will not be any feeling of utter exhaustion, such as sometimes precedes a late dinner, nor will the quantity eaten at dinner be likely to be excessive, as it is occasionally apt to be when the meal is taken in the evening. After dinner there is the opportunity of quiet rest, the family chat, the perusal of the newspaper (which cannot be called mental labour), and, it may be, the coveted pipe. At 8 o'clock a cup of tea is refreshing, and certainly harmless for most people; and afterwards no other meal is called for until the following morning. For those who do not leave their work until late in the evening, the existing arrangement of mid-day dining is perhaps a less evil than dining, say, at 8 or 9 p.m., since at that time the powers of the body, including that of digestion, are reaching their minimum. Perhaps an ideal arrangement would place the most important meal on rising in the morning, when the whole body is refreshed by the slumbers of the night, and when the digestive organs, like the brain or the muscles, are prepared for the new day's labours, while the remaining meals would be placed in an order of diminishing heaviness corresponding to the decline of the bodily powers towards evening. But there are practical reasons against this, as well as some theoretical arguments, which need not be mentioned. The plan has not the slightest chance of ever being adopted in our present habits of work.

The necessity of good cooking, and skilful compounding of food-stuffs, will have been inferred from what has been already said. Cooking loosens and softens the fibres of meat and other articles of diet; it supplements mastication, and saves the body a large amount of selection and discrimination which would involve considerable digestive labour. The right proportions of necessary foods are approximately found by the intelligent cook, and are presented to the body, judiciously mixed with condiments, in a way calculated to promote the secretion of the solvent juices.

Such are a few of the hygienic rules which physiology supports or explains. Others might, with advantage, be added if time, and the prescribed scope of this physiological lecture, permitted us to follow this digression into practical questions. We must be content to have illustrated one or two of the most salient points arising out of the subject of this evening; and we must leave the extension of the practical side of it to another lecture and another lecturer.

THE EAR AND HEARING.

By F. M. PIERCE, M.D., B.Sc.

THE subject which I have to bring to your consideration this evening is "The structure of the human ear and the sense of hearing"—a sense which has enabled you to listen to many previous discourses delivered in this hall by my predecessors, under the auspices of the Manchester and Salford Sanitary Association. Before considering the sense of hearing, I wish to call your attention to the two chief factors in the act of hearing, viz., the properties of sound and the structure of the ear. The exciting agent of all impressions on the ear is sound, and the sense of hearing enables us to detect sounds and judge of their pitch, intensity, direction, and distance. Sound is the result of very rapid vibratory movements imprinted on elastic bodies. Voice is sound produced by rapid vibrations of the vocal cords of the windpipe, and the power of these vibrations is sometimes so great that a vase may be cracked by singing into the mouth of it. This curious fact was known ages ago, and is mentioned in the Talmud. Sound can only be perceived when the vibrations producing it are repeated a certain number of times in a given period. By means of an instrument termed a siren, the number of vibrations can be regulated, and the note corresponding to any known number of vibrations can be obtained.

It has been observed that the human ear ceases to appreciate sound when the vibrations of the elastic body affected are less than thirty-two simple vibrations in a second for low sounds, and more than 38,000 in a second for high sounds. Beyond these limits it is impossible to distinguish one sound from another. When the vibrations are from 4,500 to 5,000 the sounds produced have a painful effect on the ear. Allowing for the differences of tuning, the notes of a piano range from twenty-seven to 3,500 vibrations per second. The D, high "Re" of the piccolo of the orchestra, is 4,752 vibrations per second; the lowest note is low "Mi," E of the double bass, which corresponds to forty-one vibrations in the same time. The cricket on the hearth produces a very high note, but to some people it is quite inaudible. The note of the organ pipe, corresponding to thirty-two vibrations per

second, is so faint that it is like a whisper, and can be heard by few. Sound travels through the air at the rate of about 1,122 feet per second, or only about one-fortieth of the speed that light travels, hence the thunder is heard long after the lightning's flash. Whether high or low, all sounds diffuse themselves in the air at the same rate of speed. If this were not so, we should never hear all the instruments of an orchestra at the same time. Sound reaches the ear chiefly through the medium of the air, which is thrown into vibration, like the waves produced when a pebble is thrown into a pool of still water. That air of an ordinary density is necessary for the transmission of sound is seen by the following experiment, in which the striking of a bell under a glass jar full of air cannot be heard after exhausting the air.

For the same reason the rarefied air on mountain tops requires one to speak loudly. Sound is well diffused through fluids like water, and owing to this property divers can hear sounds produced on shore whilst in deep water. Again, solid bodies like rods of wood and other materials, conduct sound well, as observed amongst various tribes of savages. We all remember in "Robinson Crusoe" how "Friday" put his ear to the ground, or to one end of a stick, the other end of which was resting on the ground, in order to hear distant sounds. The most modern application of this principle of the conduction of sound is seen in the invention of the telephone, by which the human voice can be conveyed distinctly over distances hitherto unknown. A damp atmosphere conducts sound better than a dry one, so that people hearing distant bells often know it for an omen of bad weather. One very important property of sound is that it can be reflected so that a person placed between the source of the sound and the reflecting surface can hear nothing. Professor Gavarret tells of a cathedral in Sicily in which a confessional was so placed that the confessions of the penitent were reflected by the arching of the roof to a distant point in the church; and a citizen of the town accidently discovered the fact and used to listen to the confessions only intended for the ear of the priest. All sound is complex, consisting of the fundamental sound and a number of additional sounds, called harmonics, which blend into a single sensation. The octave is always composed of a number of vibrations per second, double that of the fundamental note. The difficulty which the ear experiences in separating harmonic notes is the reason why some of the best musicians occasionally mistake an octave.

Having briefly considered the chief characteristics of sound, let us now describe the other important factor to hearing, viz., the ear. Like the organ of sight, that of hearing is double, and in mankind it is a very delicate organ, and therefore enclosed by Nature in the hardest bone of the body. That part of the ear which is visible and most familiar to all, called the auricle, has little or nothing to do with hearing, and has often been removed without serious impairment to that function. The custom of wearing earrings is a remnant of the barbaric ages, and is frequently productive of great deformity of the lobe of the ear, dragging it down by the weight of the ornament attached to it, and causing permanent disfigurement and often severe inflammation. The process of piercing the ears, as generally practised, is not unfrequently followed by great irritation and thickening of the lobule. Unlike the eyes, the two ears are not in much sympathy with each other, and one may be entirely destroyed without affecting the other. This want of good fellowship and connection between the two ears rather spoils the old saying that "what goes in at one ear comes out at the other." All sounds from the two ears mingle in the brain, and from this peculiarity of the ear, Zeno drew the precept that "Nature has given us two ears and only one mouth in order to teach us we should speak little but listen a great deal." The human ear consists of a bony tunnel, termed the outer ear, about three-quarters of an inch long and one-third of an inch broad. The outer part is fibro-cartilaginous, and the inner part bony. At the junction of the outer with the inner portion is situated a circle of glands which secrete the wax, and this oily product seems to act like a front door to the ear, protecting the deeper parts from the entrance of water, dust, and insects. Across this tunnel is stretched near its end or inner part a strong curtain, or membrane, composed of three layers, an internal mucous layer, a middle fibrous layer, and an external, or cutaneous, layer. This curtain, which completely divides the outer from the middle ear is the membrana tympani, or drum of the ear, in popular language. This membrane is oval, slightly hollow and oblique from above downwards; the more oblique the more perfect the hearing within certain limits. The chief action of the membrana tympani is to vibrate and transmit the vibrations produced by sound to the internal ear. If this membrane becomes thickened its power of vibrating lessens, and the acuteness of hearing diminishes. Behind this curtain or membrane the end of the

tunnel expands, and is connected by a narrow tube with the back of the nose. This narrow passage is called the Eustachian tube, and serves to convey warm air from the back of the mouth and nose to the space behind the membrana tympani, which is called the middle ear, and this air serves to regulate the pressure behind the membrane and that outside it. By keeping the mouth open artillery men can diminish the concussion of the air on the membrane during the firing of heavy ordnance, and in the same way the occupant of a diving-bell lessens the unpleasant effect produced in his ears by the pressure on his membrane of the condensed air. When a hole exists in the drum a smoker can force smoke through the tube and out of the external ear. Across the

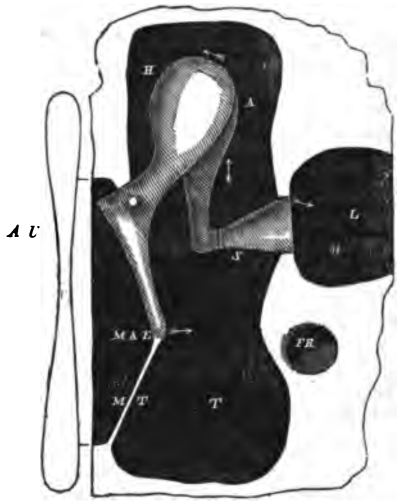


Fig. 1.—Diagram showing the Relations of the Ossicles to the External Auditory Canal and Labyrinth: *T*, cavity of the tympanum; *L*, labyrinth; *M A E*, meatus auditorius externus; *H*, hammer; *A*, anvil; *S*, stirrup; *M T*, membrana tympani; *F R*, fenestra rotunda; *A U*, auricle.

middle ear, from the membrane to the end of the tunnel facing it, is slung a kind of suspension bridge of small bones, which are termed the anvil, the hammer, and the stirrup bones, the latter being attached to a hole in the wall of the middle ear, called the oval window, which is covered with membrane, and leads to a number of small canals in the bone, in which the nerve of hearing,

on its arrival from the brain, is spread out on a series of soft membranous convoluted tubes, which float in a peculiar fluid. These bony canals with their contents constitute the semi-circular canals, three in number, a horizontal, a superior, and a posterior canal. It is supposed by some physiologists that they are concerned with the maintenance of the equilibrium of the body. A fourth excavation in the bone is named the cochlea, and contains the most important part of the acoustic nerve. The cochlea is like a snail shell, having three double turns or whorls in it, and on the floor of each turn or storey is spread out a membrane which contains a structure resembling the keys of a piano, and termed the rods and cells of Corti. There are about 3,000 of these rods, each one of which re-acts to a certain number of vibrations. For every half tone of our present musical scale, there must be in the cochlea at least thirty-three strings, to represent all possible shades. It is in consequence of temporary or permanent morbid pressure on these terminations of the nerve of hearing that we get, in part, the troublesome noises in the head from which so many suffer.

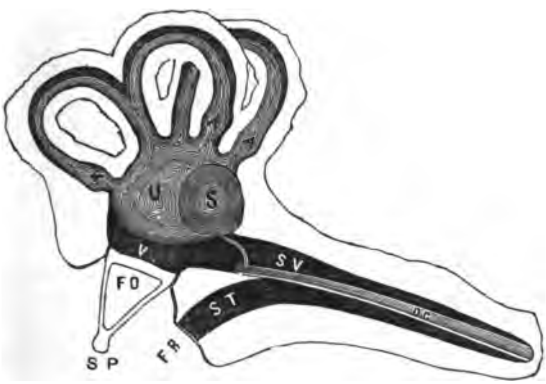


FIG. 2.—Diagram of the Labyrinth: *V*, the vestibule, or central cavity, which is nearly filled by the utricle (*U*) and the saccule (*S*). Near the foot-plate of the stirrup, there is free fluid, which also extends up into the scala vestibuli (*S V*) of the cochlea. *D C*, the ductus cochlearis, which communicates by a slender membranous channel (canalis reuniens) with the saccule Between the cochleal duct and the scala tympani (*S T*) is a narrow white band, representing the membrana basilaris. At the extreme tympanic end of the scala tympani, a faint white line indicates the position of the membrana tympani secundaria. 4, *A A*, ampullæ of the membranous semicircular canals, which, in these regions. fit pretty closely their surrounding bony walls. *S P*. stapes. *F O*, foramen ovalis. *F R*, foramen rotundum or the membrana tympani secundaria.

The middle ear and Eustachian tube are lined by mucous membrane, like the nose. The roof of the middle ear is only separated from the brain by a small plate of bone; the floor and front are situated close to large bloodvessels, and one side of the middle ear, opposite to the entrance to the Eustachian tube, leads to large cells in the mastoid bone, or bone at the back of the ear. The inner wall of the middle ear, facing the membrana tympani, has two openings in it; to one—the fenestra ovalis, or oval window—the stirrup bone terminating the chain of ossicles, is attached, and the other—the fenestra rotunda, or round window—leads to the interior of the snail shell, or cochlea. Both these windows are covered with membrane. The cochlea is chiefly concerned in the appreciation of the character, timbre, and pitch of sounds·

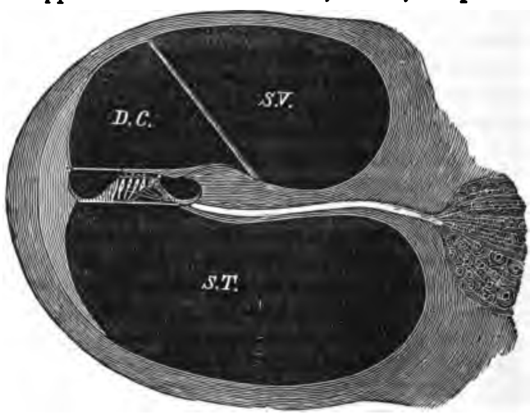


FIG. 3.—Transverse Section of a Cochleal Whorl. On the right, embedded in the substance of the bone, is a group of *ganglion cells*, through which the fibres of the auditory nerve pass before entering the *lamina spiralis ossea* This latter is represented in the figure as a broad septum, separating the *scala vestibuli* (*S V*) from the *scala tympani* (*S T*), and containing a canal for the passage of the auditory nerve-fibres. In the canal these fibres still possess a medullary sheath, but, on emerging therefrom into the *ductus cochlearis* (*D C*), they break up into naked axis-cylinders and terminate (as white threads in the drawing) in the single *inner* and four *outer hearing cells*. The cilia of the four outer-hearing cells may be seen projecting through the *lamina reticularis*; those of the single inner cell (invisible in the drawing) project above the head of the *inner pillar of Corti*. The lamina reticularis is drawn as an horizontal projection (outward) of the upper portion of the head of the *outer pillars of Corti* Underneath, these pillars rest upon the *membrana basilaris*, which terminates on the outer side in the *ligamentum spirale*, represented in the figure as a pale, crescent-shaped pad of connective tissue, fitting accurately to the surrounding shell of bone). The cilia of the hearing-cells come into contact above with the *membrana tectoria* or *Corti's membrane*, which springs from the upper side of the lamina spiralis ossea, near its free extremity, and terminates, by a thin extension, in the ligamentum spirale. *Reissner's membrane* is represented as a strait band, which stretches from the bony wall above, down to the upper side of the lamina spiralis ossea, and separates the ductus cochlearis from the scala vestibule.

The mode by which the ear exercises its function is as follows:—Waves of sound, as in ordinary speech, pass down the tunnel of the ear, and, striking upon the membrana tympani, set it in vibration, and from the membrane, these vibrations are conveyed, partly through the air of the middle ear, and partly along the chain of small bones, to the cochlea and semicircular canals, when they fall upon the expansions of the auditory nerve, and are transmitted to the brain, the grand interpreter of all the sensory nerves.

Like the other senses, the ear is capable of being greatly developed by training, especially by music. Savants are undecided whether any difference exists between the two ears in those who are known to possess perfect hearing, some investigators believing that the hearing of the left ear is always more acute than the right. From the influence which the sense of hearing exercises on the temperament and condition of the human frame, it may perhaps be regarded as the most useful of all the senses. The question is often asked, "whether is it worse to be blind than deaf," and the query is one by no means easy to decide. The countenance of the deaf man generally wears a melancholic and somewhat anxious expression, whilst that of the blind is more serene and composed, and the temperament is more generally a contented one. Deafness, with its frequent accompaniment of noises in the ears, engenders a suspicious and irritable manner in those afflicted with it, and cases are recorded which have even led the sufferers from this disease to commit suicide. Thus it is related that when Beethoven became deaf he was often tempted to put an end to his existence. A deaf person feels that his affliction is more or less an annoyance to those with whom he comes in contact, and this knowledge leads him to adopt pursuits of a contemplative and retiring character. The organ of hearing is always in action ; even in sleep, whilst all other senses slumber, the ear alone is like a sentinel on the watch to guard us. Shakespeare refers to the belief of his time that poisons may be introduced into the ear during sleep with fatal effect, and illustrates this in the play given by Hamlet before the King of Denmark. It is now well known that the action of poison administered through the normal ear has but a very limited effect.

Having thus briefly described the properties of sound and the structure of the ear, I must not forget the main object of the Association in diffusing a knowledge of the sanitary conditions necessary for the healthy maintenance of the functions of the

human body. In deafness, we have to deal with a loss of hearing which may be produced in many different ways, most of which can be largely avoided by attention to simple precautions, to some of which I shall call your attention. Deafness may be of two kinds, either congenital or acquired. In the first, the congenital form, the disease is often hereditary, and statistics show that it is sometimes due to the intermarriage of near relations. The statistics of all countries show that the number of male deaf mutes greatly exceeds that of the female. In Prussia, for 1871, the proportion was 100 : 85·1, and as the female population nearly everywhere exceeds the male, this proportion of deaf mutes is absolutely and relatively greater. In Europe, the smallest number of deaf mutes is in the Netherlands, viz., 3·4 in 10,000 inhabitants, and the greatest number in Switzerland, 24·5 per 10,000. In Great Britain the number is about 5·70. It is said that there are more deaf mutes than blind in mountainous districts, whilst in the lowlands the proportion is the reverse. How far social or territorial influences affect this question, and which series has the most decided effect, is still matter of controversy. With congenital deafness, dumbness is necessarily allied, for perfect articular speech cannot be acquired by anyone without good hearing. The condition of a deaf mute child is indeed a sad one; strong and capable in all other respects, the loss of hearing and inability to speak shuts him off from the rest of the world. Mr. Herbert Spencer has lately described (I think unjustly) the deaf mute as comparable with "the untaught child and the savage, and like them and the brute, think only of things which can be touched, seen, heard, tasted, etc., but unlike the developing man, has no thoughts about intangible invisible existences." The first words learnt by the deaf mute are "Ma" and "Pa," as a result of involuntary physical instinct, like the "chut-chut" of the chaffinch, but the love of parents has since the Creation deceived itself by imagining that the child called for its father and mother. In many languages "Ba" stands for father, and "Ma" for mother, but again in many other tongues the terms are reversed. The defective education of the deaf mute shows its effect in a certain wilfulness and temper, though other senses, especially those of sight and touch, improve and compensate him for the loss of hearing. It is related of a deaf mute girl that she could understand what her sister said by placing her hand on the mouth of the latter; and another deaf mute is stated to have understood words written on the forehead with the

finger. A child does not begin to notice sounds until from four to six months of age, and a suspicion that the child is deaf is not likely to trouble the parents until it is at least a year old, and it is with great reluctance that an anxious mother is forced to believe at the end of two years that there is some serious defect in the hearing of her infant.

Of the two systems of instruction for deaf mute children, viz., the finger alphabet and the German system of lip-reading, I cannot have the slightest hesitation in recommending the latter, as it enables those who are taught that system to understand most people, and to speak and act amongst their fellow creatures without attracting the painful notice of the bystanders. Children should be early instructed in the oral method, and not permitted to combine it with the finger alphabet. The oral, or system of lip-reading, should, I think, be taught in all schools for deaf mutes, and it seems very desirable that the school boards of our larger cities should establish a class for the instruction of deaf mute children, and for those whose deafness renders them unable to profit by the ordinary mode of instruction. There are many causes of deafness, and one of the most potent is the variable climate of our country; the liability to cold attacking the nose and throat, certain illnesses like typhus, scarlatina, and mumps, the immoderate use of certain drugs, such as quinine, &c., the practice of indiscriminate bathing, and the noises of certain trades, like boiler-making, these all pre-dispose to produce some form of deafness. All persons who have the slightest tendency to trouble with their ears should avoid the entrance of water into the ear, and abstain from diving, and perhaps, in some cases, entirely from both fresh and salt water bathing, and I cannot too strongly set my face against the use of the many little instruments and contrivances intended to scoop out every trace of wax which I have shown before Nature has placed in the ear for an express purpose. The study of diseases of the ear is still, I regret to say, a neglected subject in the education of most medical men, and is only now beginning to take its proper place in the chief medical schools of the country. To this fact is largely due the unfortunate errors into which the public and many medical men fall in their views of the causes and treatment of loss of hearing. It is no uncommon thing to hear people say that "a discharge of matter from the ear is healthy, and must not be stopped, that it will cure itself, and that interference will produce worse results than deafness." Let

me assure you these views are entirely opposed to scientific knowledge on the subject, and are utterly mistaken. A discharge from the ear should be promptly attended to, whether in a child or an adult, and with as little delay as you would attend to any other serious complaint. A purulent discharge from the ear is now regarded by insurance offices as a serious drawback to the acceptance of otherwise healthy lives. Fortunately, we now know that the so-called drum of the ear is of comparatively little importance, and that many people can hear very well in whom the drums have been almost entirely destroyed, provided the chain of small bones is not at the same time entirely removed. Science has also provided us with the means of replacing the lost membranes by artificial ones, which often produce wonderful improvement. Whilst I am referring to the subject of artificial drums, I may here allude to certain other artificial aids to Nature, of which the hearing trumpet and the audiphone are types. Useful as each of these instrument sometimes proves to those whose cases do not admit of remedial treatment, I am bound to acknowledge that aurists have not yet discovered any apparatus of equal benefit to the deaf comparable to the advantages obtained by the use of proper spectacles to those who are afflicted by defective eyesight. Whoever discovers satisfactorily spectacles, or its equivalent for the deaf, will confer a great blessing on a considerable portion of the human race. How much better, however, is prevention than cure? And to secure the former condition there must be a complete departure from some of the mistaken practices still in vogue. Aurists are often called upon to witness the sad effects upon the ear of various unfortunate customs and habits, against which a strong protest is required, and one in particular, that of punishing the refractory child by boxing its ears. Never strike a child on the ear, as such blows often lay the foundation of deafness in after life, and have in some instances caused fatal results. Many of those who now use an ear trumpet or audiphone might have been spared that inconvenience had they not thus been ill-treated in youth, by early attention to the ear, and by the avoidance of the injurious nostrums with which people delight to fill their ears. There are some very curious defects of hearing, of which a most remarkable form is that in which the hearing of articular speech is greatly improved during the continuance of loud noises, such as the vibrations of a carriage, the rattling of machinery, or the splashing of water. Those people who are the subjects of this

peculiar form of deafness, termed Paracusis Willisii, can often hear conversation in a noisy tram or carriage at a distance at which speech would be inaudible to those with perfect hearing. The sense of hearing, like our other senses, plays sad tricks with us. Illusions and hallucinations of hearing are not uncommon, as the memory and imagination may upset our judgment of the distance and direction of sound. Ventriloquism and the curious effects of echoes are well known forms of this illusion, and certain mental affections also are frequently causes of these hallucinations. Mahomet conversing with the Angel Gabriel, Joan of Arc with the saints, Luther disputing with the devil, and throwing his ink bottle at his head, are all celebrated instances of this kind of delusion. All our senses are equally valuable to us, and in these days of active competition and of increased nervous energy every sense is called upon to act well and to act quickly. The rapid advance of scientific knowledge and its application to the various occupations of every-day life requires increased intelligence on the part of those engaged in them, and a confiding public daily trusts its safety to the acuteness of sight, the quickness of hearing, and perfection of the senses of railway, telegraph, and telephone employés. How increasingly important, therefore, does it not become that all of us should treasure carefully, and avoid practices injurious to one of the greatest gifts that God has bestowed upon us—the sense of hearing.

PARENTS AND CHILDREN.

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THE title of my lecture conveys to you no very definite meaning, and purposely so, for I found it difficult to convey in a title the exact ground I wished to go over. Some years ago I gave a lecture on the mode of rearing young children from their birth, so as to give them the best chance of growing up well and strong. What I have to say to-night is really a completion of my former subject, regarded from a different and not-so-often-thought-of aspect. This aspect is, as far as it can be expressed in a few words, that our duties towards our children do not begin only with their birth, but date much further back. To what extent and in what manner, I trust you will understand more clearly at the end of the lecture.

In the first place, I wish to say something with regard to what we call *heredity*. You know what is meant by inheriting money, land, or titles; only a certain number of us do that. But every child born into the world has an inheritance of infinitely greater importance than these accidental surroundings—that is to say, certain physical, mental, and moral qualities derived more or less directly from his parents and ancestors.

Firstly, there are the qualities or attributes by which he is a man, *i.e.*, *human*, as distinguished from the lower animals. Next, he possesses in some degree the physical aspects of the particular race to which he belongs. Even in the case of those closely allied, as in Great Britain, we can frequently distinguish the different races clearly. Still more easily can we do so where they differ in colour as well as in features, as with Chinese, Indians, negroes, &c. The Jews present us with a remarkable instance of a people scattered all over the world, subjected to the powerful

modifying influences of its different climates, &c., and yet retaining markedly certain physical features and mental powers, such as their financial ability. In the case of the Gipsies we have a similar, though less marked example, a people living for generations in the West, and yet preserving strongly the characteristics of the Oriental race from which they sprang. These facts are due to their intermarrying with their own people respectively; when they cease to do so their peculiarities become gradually effaced. In the next place, there is man's family likeness, which more immediately concerns us. The child may resemble his father most, or his mother; he may combine in a tolerably equal degree the qualities of both parents, or he may have qualities which are not clearly traceable to either. In the last case the child may have developed new qualities, but not necessarily so. All who have given thought to this matter must be familiar with instances where a child resembles one of its grand-parents, or some still more remote ancestor, much more than it does its own parents. This law of heredity is called *atavism* (*atavus*, an ancestor) or *reversion*. In the case of families of the better class possessing generations of ancestral portraits, this point is often strikingly exemplified, a child in a family sometimes showing no marked likeness to any of its living relations, but a wonderful resemblance to some ancestor many generations back. In the case of cross breeds, either in the human race or the lower animals, it is the general rule that while the first generations are nearly intermediate between their parents, the succeeding ones tend to return to the characters of one or other of the original progenitors. Mulattoes, as you know, are the offspring of a white and a negro parent, and partake of the features, &c., of both; but their children show a frequent tendency to be either much blacker or much whiter than their parents.

The possibility of all these combinations gives rise to the infinite variety of bodily and mental character which we find in members of the same family. In addition, we may find children born with qualities of body or mind for which we cannot find a hereditary explanation. This may be either because we have not full information, or that the child really has certain individual qualities in addition to those which in any reasonable sense he has inherited. This applies, perhaps, more strongly to mental and moral qualities than to bodily ones, and it is to the last I wish chiefly to direct your attention.

Examples of inheritance in all parts of the bodily frame are

common. Sometimes, for instance, one marked feature may be transmitted through many generations. This was familiar to the ancient Romans, who even named families accordingly, as the Nasones (those having large noses), Buccones, &c. In modern history the long upper lip of the Hapsburgs—the present Royal family of Austria—is a well-known instance. Or it may be the shape of hands or feet, the stature, length of limbs, &c. Certain families are distinguished for their beauty of form, or for their strength. Length of life beyond the average is also hereditary in certain families. This is probably connected with the fact that, as one would naturally expect, finely-formed and healthy internal organs are just as much inherited as external features.

These preliminary remarks bring me then to my first point, that every child has what we may call a birthright to health, or, to use a homely phrase, the right to enter this world sound in wind and limb.

But, unhappily, just as health and strength may be inherited, equally so may weakness and disease, or the tendency to disease. Instances of this must be familiar to you all, that certain diseases tend to "run in families," as it is called. I might give you a long list of such, but must content myself with a few. For example, gout, rheumatism, consumption, dyspepsia in its various forms, asthma, enlarged tonsils with a tendency to quinsy, nervous affections, &c. Again, we often find in families, by inheritance, groups of diseases, which seem to the layman to be very different, and yet which the medical man knows are closely allied. For instance, a consumptive parent or parents may have one child die of inflammation of the membranes of the brain (tubercular meningitis), another of "inflammation of the bowels" (tubercular peritonitis), a third may have chronic disease of bones or joints, another suppurating glands. Those who escape such dangers may later in life become victims to what is ordinarily known as consumption, *i.e.*, tubercular disease of the lungs. Another family group of disease might include in its members rheumatism, heart disease, St. Vitus' dance, gout, and apoplexy. Others might be instanced, but it is hardly necessary.

In certain curious cases deformities, or purely accidental mutilations, tend to become hereditary. A gentleman whom I know was born with two thumbs on each hand, no other instance of this being known in his family. All his boys (four) have been born with a similar condition, but none of his girls. Again, M. de

Quatrefages says that among the Esquimaux the tails of the dogs are usually cut off for convenience in their work of drawing the sledges, and that their pups are often born without tails. This is probably allied to the fact that where a faculty or sense is disused for generations, it tends to become less and less developed, as is seen in the case of the sightless fishes found in the caves of Kentucky. In like manner a disease acquired by an individual may tend to become hereditary.

I should explain here what I mean by inheriting a *tendency* to disease. Supposing a child catches cold, as we usually express it. If the child come of a healthy family the cold probably passes off, and the child is none the worse. But if otherwise, the cold may develop the hidden hereditary weakness, showing itself in an attack of rheumatism, quinsy, bronchitis, pleurisy, &c. It is fairer to speak, I think, of the tendency being inherited in most cases than the actual disease. Gout is undoubtedly hereditary, but as a rule it only appears late in life, so that for practical purposes it is non existent in earlier years, and may never become developed if the man lives very carefully. In the case of syphilis (that is, the constitutional form of venereal disease) not only is the tendency transmitted to the offspring, but the actual disease, the blood poison, producing effects proportioned to its intensity. It affects the child before it is born. If severe, the result may be the birth of one or a succession of still-born children, killed before birth by the violence of the poison. If less severe, the children may be born alive, but suffer from the disease in varying forms and degrees afterwards.

I purposely, in this lecture, refrain from going into the question of the inheritance of mental powers and moral qualities, because, although they are undoubtedly transmissible, they are less clearly so than purely physical attributes, and happily, as to bad or weak ones, are more strongly under the good influence of education and surrounding circumstances.

The tendency to physical disease which a child inherits may also be greatly lessened by care and by good hygienic surroundings, so that the actual disease may never become developed. Still it is evident that the chances of health and strength, and of usefulness and superiority in the battle of life, must be greatly in favour of the one who begins life with sound health—the *mens sana in corpore sano.* Undoubtedly in the long run the "fittest" will survive.

Medical men attach great weight to what they call the family history in judging of the probable results of a disease in any individual. If the family history is *good*, we judge that the patient's chances of perfect recovery are much better than those of another patient affected by the same disease and apparently not inferior in physical powers, but whose family history in its physical aspects is bad. In this family history we try to ascertain the general state of health of parents, brothers and sisters, grandparents, and, to a less degree, of uncles, aunts, cousins, &c.; we also inquire into the nature of the illnesses they have had, the number of deaths, the ages at death, the causes, and so forth. These facts afford us valuable guides to treatment, as well as in judging of the probable result. If, for example, a child is brought into hospital with an injury to the knee joint, if the child seems healthy and has a *good* family history—we judge that with rest, &c., for a moderate time—the child will recover with a good joint; if, on the other hand, the family history is *bad*, as, for instance, the occurrence in near relatives of consumption, strumous glands, chronic joint disease, &c., we decide that greater and longer continued care will be needed, and that even then the result is much more doubtful, the end being possibly chronic disease of the joint and a crippled limb, with damaged general health.

The powerful influence of heredity upon an individual's chances of health and length of life is eminently recognised in the practical business of life. For instance, if you wish to insure your life, the company is not satisfied merely to know that you at present have no disease; they are equally, if not more desirous of knowing the state of health of your parents and near relations, the causes of their deaths, and their ages at death. Suppose, for example, two people apply for life insurance, both delicate-looking, but having no definite disease; but the family history of the one is *good*, while in the other case parents, brothers and sisters, or other near relations have died of consumption. In such a case, the company would probably accept the one and reject the other upon the family history; that is, upon their knowledge that although the individuals themselves seem very much alike, the chances of length of life are very much in favour of the one with a healthy ancestry.

In connection with this, I may mention that just as likenesses may skip a generation, so occasionally, although not so frequently, diseases or disease tendencies may likewise do so; atavism may show itself in disease as in health.

I might bring before you many more facts of the greatest interest in connection with this subject of inheritance; it is so interesting that the chief difficulty is to restrain oneself and condense. Those who are wishful to know more will find stores of information and reference in the works of such writers as Darwin and Francis Galton, in England; and Ribot, in France. Many of the points are still debateable and in need of further research; but I have purposely kept to proved facts, and now wish to bring before you some practical deductions therefrom. These I offer in their purely medical aspect, as affecting the health of children. Serious thought upon this matter is forced upon us by the large numbers of *inheritors of feebleness* who come under our care, especially in hospital practice, *i.e.*, the children of the poor, the very class who, lacking other advantages, most need strong bodies and sound minds.

1. We may fairly say that a man or woman with marked disease, such as phthisis, ought not to marry. Mr. Galton says—"Few would deserve better of their country than those who determine to live celibate lives, through a reasonable conviction that their issue would probably be less fitted than the generality to play their part as citizens."*

With regard to syphilis, which I have already spoken of as occupying a position somewhat by itself, I should say this—No one who has suffered from it should marry without first seeking competent medical advice. I have seen repeated instances in which a man, believing himself well, and being so, as far as any discoverable symptoms were concerned, has married, and his children have been born affected, or even died from the disease. How long a time should elapse of apparent good health would have to be decided in each case, and this is not an easy task, for it is certain that the poison may affect the offspring after years have elapsed. The wisest plan is not to incur the risk of a malady which afflicts not only the offender but his innocent posterity.

2. Few families are what we might call *absolutely* healthy—most of them have certain disease tendencies. If, then, two individuals marry from families having the same disease tendency, such as gout, consumption, &c., it will probably be intensified in the children. If the parents inherit different family tendencies, then one or both may be lessened in the children.

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* Inquiries into Human Faculty and its Development. By Francis Galton, F.R.S., 1883.

3. The marriage of cousins, or close relations, is objectionable from the same point of view. If we could put it mathematically, we might say that in the children of cousins the tendency to a family disease would be doubled, whereas, if each married into another family the tendency would be halved—that is, it would be four times as great in the one case as the other. Of course, as children do not inherit their qualities equally from their parents, and there are so many disturbing elements, it is not a matter of mathematics. But this rough way of stating the matter shows the nature of the risk.

In addition to this, however, although it is doubted by some, the great bulk of authorities believe that the marriage of close relations is bad, as in itself tending to the degeneracy of the race, especially to the production of nervous and mental defects, such as deaf mutism, &c. In the case of the lower animals, it is the experience of practical men that continued inter-breeding is followed by evil consequences. In the case of man, as Darwin says, "The question whether evil follows from close inter-breeding will probably never be answered by direct evidence, as he propagates his kind so slowly, and cannot be subjected to experiment; but the almost universal practice of all races, at all times, of avoiding closely related marriages is an argument of considerable weight; and whatever conclusion we arrive at in regard to the higher animals may be safely extended to man."

On the other hand, we often find that intermarriage between individuals of different races, *provided they be not too far apart* in the scale of humanity, results in an improved offspring. Each tends to supply some quality which the other lacks, or to tone down some one which may be too pronounced. These results are constantly seen in intermarriages of members of different civilized races, and need not be particularised. It is a curious fact, which may be noted by the way, that the offspring of races far apart often tend to become very degenerate. A native of the Zambesi put it thus to Dr. Livingstone, "God made white men, and God made black men, but the devil made half-castes."

4. The question of early marriages is a little complex. If we mean marriage before the parents have arrived at maturity, then they are most objectionable. The children are less likely to be strong, and the mother's health is more likely to be injured. Of course, the age at which full-grown manhood or womanhood is attained varies much in different countries and different individuals.

But one might safely say as an average, applying to our own country, that a woman had better not marry under twenty, or a man under twenty-three or twenty-five.

In Manchester, and other large factory towns, the evils of early marriages come before us under another aspect, not purely medical, but yet having a disastrous influence on the life and health of children. As the women earn wages in the mills, it too often happens that a young man and woman marry on the strength of their joint earnings, before the man would be in a position to support a wife. What follows? In a year or so a baby is born, meaning increased expense, so that the mother must get back to her work as soon as possible. The child is either not suckled at all, or only in the intervals of work; at other times it is left to the tender mercies of some old woman or young girl, possibly well meaning, but almost certainly ignorant of how to feed or care for the baby properly. These children die in unduly large proportion, or if they live, are feeble, rickety beings. Children are born very often in rapid succession, and with the same result, while the mother's health is too apt to fail from this, and the necessity for going back to work long before she is fit for it. That this is no overdrawn picture will, I am sure, be vouched for by all who, like myself, have had much to do medically among the children of the factory classes. Is it, therefore, saying too much to conclude that a man should not marry unless he has a reasonable expectation that when his wife becomes a mother he can afford to let her have the rest which is necessary for her own health, and for the proper rearing of her child in health?

But we must not forget before leaving this branch of my subject to show the other side of the picture. When a young man has attained to manhood, and can afford to keep a wife in the sense I have named, then it is not wise to postpone marriage till too late. Statistics show that while the children of young (but mature) parents may be more numerous, they are also as a rule more vigorous than those of older parents, and besides the chance of seeing the children grown up and fairly launched in life is necessarily greater.

5. I have stated that a peculiarity, coming as it were by accident in an individual, or some quality developed to an unusual degree in one member of a race tends to be handed down to his descendants either immediate or more remote. It is by taking advantage of this, which is one of the best known facts with regard to here-

ditary transmission, that gardeners and breeders of animals have been able to produce the numerous varieties that now exist. Take, for example, the case of horses. A breeder finds two individuals presenting, by chance, the same quality in an unusual degree, say speed. By pairing these, their offspring, or certain of them, will probably possess this quality in a higher degree, and so by a series of such artificial selections the desired quality becomes more and more marked. By processes of this kind the English thorough-bred race horse, for example, has been created and gradually made more perfect in the last 150 years.

Methodical selection such as this is manifestly impossible in the human race, although much good is done even there by what Darwin calls unconscious and natural selection. Man naturally seeks for his mate one who possesses superior charms of body, mind, or spirit, so that while there are many disturbing elements, such as the attractions of mere wealth or position, or the depressing influences of poverty, the tendency of unions among civilised people is on the whole towards the improvement of the race.

Darwin, in his "Descent of Man," says:—"Man scans with scrupulous care the character and pedigree of his horses, cattle, and dogs before he matches them; but when he comes to his own marriage he rarely or never takes any such care. He is impelled by nearly the same motives as are the lower animals when left to their own free choice, though he is in so far superior to them that he highly values mental charms and virtues. On the other hand, he is strongly attracted by mere wealth or rank. Yet he might by selection do something not only for the bodily constitution and frame of his offspring, but for their intellectual and moral qualities. Both sexes ought to refrain from marriage if in any marked degree inferior in body or mind; but such hopes are Utopian, and will never be even partially realised until the laws of inheritance are thoroughly known."

The practical point which I wish to bring out of these considerations clearly and plainly is this. Just as peculiarities (or even accidents), not obviously hereditary in a man, may be transmitted to his descendants, so also a disease, which he has not inherited, but become afflicted with, through whatever cause, may be, and often is, transmitted as a disease, or a disease tendency, to his posterity. This is undoubted, and indeed throughout what I have said I have tried to keep only to proved facts, resisting the temptation to wander into the many points of great interest on the question of heredity which lie on the more debateable line.

This fact then—and I now appeal to the younger members of my audience—does it not add weight to that which is a sacred duty to all, namely, not in any way to lessen or waste the precious gift of health? You cannot of course help it if you come into the world with this or that inherited tendency to disease; but you can, by living according to the laws of health, lessen these tendencies, and still more emphatically, should you do all in your power to avoid setting up new diseases or tendencies which may be transmitted to your descendants.

Most of you will marry; if then it is your duty to take care of your health for your own sakes, it is still more imperatively your duty to do so for the sake of your children and future generations.

The young man who "sows his wild oats," as it is somewhat leniently called, does not think, or possibly does not know, that he may be at the same time sowing the seeds of disease or weakness in his descendants, which, when too late, he may bitterly regret. A medical lecture on health is hardly the place for moralising, but morality and physical health are inseparable and interdependent. To quote only one form of immorality, *i.e.*, drunkenness, the family of a drunkard will as a rule be more prone to that vice, and if they give way to it their children will be more degenerate in body or mind, and one or two generations more will probably bring the family to an end—Nature's mode of stopping unlimited degeneration.

As to the other sex, they do not, as a rule, dissipate like the young men, but still they often lead unhealthy lives. They take too little physical exercise in the open air, possibly keep late hours at balls, &c., too often, eat unwholesome food, and so on. Again, their mode of dressing is usually such as not only to impair their general health, but too often in a special degree to lessen the likelihood of their becoming the healthy mothers of strong and vigorous children.

It is a hopeful sign that during the last two or three years investigations into this question of inheritance are being more systematically made, and by a larger number of persons, instead of as formerly by a few earnest but solitary workers. The "Life Histories" which are now being collected, dealing with the medical condition of families for generations, if faithfully given, are as important as the recital of their deeds and possessions, and ought to be of great service in giving definiteness and detail to our ideas on the power of heredity. That this power is great all admit in a

vague kind of way, but how great it is is only known to those who study the subject specially. As its practical bearings are so enormous, it is then clearly our duty to diffuse knowledge on the subject, especially among the young. When "those about to marry" know that on the wisdom of their choice depends not only their own welfare and happiness, but possibly the health and happiness or misery of generations, then they will realise that to choose rightly is not simply a matter of their own pleasure, but a sacred and imperative duty.

As an addition to my lecture, I am glad to be able to quote from the addresses of two of the most eminent members of our profession upon this subject. These remarks, which were made before my lecture was delivered, I only happened to see afterwards.

Sir William Gull says:—"As genealogical trees showing the rise and extension of families, with their many collateral branches and intermarriages, are found in great houses, and are regarded with pride and veneration, so we could wish that in a like manner *life histories* were found in every family, showing the health and diseases of its different members. We might thus, in time, come to find evidence of pathological connections and morbid liabilities not now suspected; and we might discover means of prevention by a better knowledge of the origin and extension of maladies through blood relation. The proposal of constructing such family life histories is an important part of this scheme of collective research, and more would certainly be gained socially by the genealogies of health and disease, their connections and causes, and by tracing the strength of the strong as well as the ailments of the weak in a family, than from such barren histories as I have referred to, which tell only of inherited fame, but do not indicate the way to perpetuate and augment the inheritance. Unfortunately there is a feeling of safety in ignorance; and there prevails in us a sort of blind superstition, a survival of the darkest ages of man, which makes us think that there is a kind of religious trust in not seeking too minutely into the ways of life, as if the intellect of man were the servant of impiety rather than, as it is—the handmaid of all that is good to us. Again, there is another hindrance to all we want in this family history, 'all men think all men mortal but themselves,' and there is a half-conscious sense of shame in admitting any liability to human frailties. This makes it a great difficulty to obtain the truth we want, though we may well excuse it, and believe it to be an instinctive tribute to the righteousness

of Nature's laws, and an unconfessed confession that many of our diseases and weaknesses are due to our own fault, and ought to have been prevented, as we trust they will be through this movement, in the course of time."

Sir James Paget, speaking at the same meeting, said:—"I would have dilated on this subject, but that Sir William Gull has treated it so fully in regard to the attainment of family histories. There is certainly no other means so good as that which may be possessed by those who have known families for generations, and who can, of their own knowledge, and not on the fallacious and often very false reports of relatives and friends, declare what has been prevalent in this and that household. And yet, if one could set before one's self the gravest and most important problem in all pathology, it would be that which concerns the inheritance of disease; and, as Sir William Gull has rightly stated, the inheritance not of disease alone, but of that which, from generation to generation, shall obliterate the disease which one ancestor may have acquired."*

* See *British Medical Journal*, January 27, 1883. Addresses on *The Collective Investigation of Disease*. By Sir William W. Gull, Bart., M.D., F.R.C.P., F.R.S., and Sir James Paget, Bart., D.C.L., F.R.S.

SLEEP AND REST.

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SLEEP is so familiar to us that we rarely consider it with the attention it may well claim.

If we think for a moment, the mystery of sleep stands out as one of the marvels of our being. The waking condition—which we call our ordinary state, that in which the business of the world is carried on, and which we have in our minds when looking back on our past lives, or forward to the time to come—is characterised by the exercise of our senses, as sight, touch, hearing, &c., and also of our will, so that we do this or that as we please. The various faculties of our mind are in active voluntary exercise; we are eager in the pursuit of whatever attracts us at the time. Some are engaged in the calculations of commerce, with the very practical object of gain before their eyes; others, no less eagerly, may be working out the more abstruse problems of pure mathematics, with no object but the intellectual pleasure to be found in the cold regions of thought most remote from human interest. With others again, the waking hours are occupied in work requiring exercise of muscle rather than of brain, though there are all degrees of difference in handicrafts as to the proportion the one bears to the other. It is impossible, however, to illustrate the various phases of life, seeing that it would be necessary to embody the whole catalogue of the infinite variety of human occupations.

Think of the contrast between the ceaseless, restless activity of the day and the stillness of repose when night falls on country villages or crowded towns. The busy feet are at rest, the voice of the city is hushed, the struggle of life is suspended—for sleep has fallen on men.

This means that the operations of the mind are more or less completely in abeyance; sensation is less on the alert; the will has ceased to control. When sleep is sound and undisturbed, the limbs are in complete repose, and the whole body is at rest.

The eyelids have fallen, so that the outer world is hidden from our view. The ear is no longer on the watch for sounds, whether strange or familiar; the touch no longer gives its protective warnings; the sense of taste ceases to minister to our wants; the odour of the rose is unheeded. We perceive nothing, and are dead to the world around us. Reason has for the time resigned her sway; the past and the future are nothing; we remember nothing; we think of nothing; we hope for nothing.

But with all this mimicry of death, vital actions are going on. The heart keeps up its never-ceasing toil, so that the blood still streams through the vessels, maintaining the warmth of the quiet limbs, enabling the internal organs still to carry on their proper work, and allowing the brain—the material instrument of the mind—to recover the energy needed for its healthy exercise.

It seems strange, perhaps, to notice matters so familiar, for sleep is as natural as the waking state. But imagine, if you can, a being like ourselves who had never slept, and was told that he would soon fall into the condition just described. Would there be no sense of dread at the giving up of all his powers of mind and body to this condition of helplessness? Would there be no struggle against the growing power of the drowsy god of sleep?

All animals possessed of a well-developed nervous system require sleep just as man does; and there is no doubt that, like man, they dream. I have a dog who often dreams, and you can be pretty sure from his ways that he is busy in the chase of rats or rabbits.

Plants, too, are said to sleep, and they certainly undergo diurnal changes of a kind which suggest a waking and sleeping condition. For example, at evening, flowers close, buds fold up, not to open again till morning.

Physiologists have tried to discover the cause of sleep, but as yet without success. It is known that all animals, and plants likewise, have periods of activity and repose, and that this alternation of work and relaxation is necessary for their continued well-being. Moreover, it is known that those organs of the body which seem to be always at work do really obtain a considerable amount of rest. Thus the heart, whose toil is never ending, always beginning, has its short interval of rest between its successive periods of work. After the contraction and dilatation of its chambers, there is a brief moment of rest before the same actions are again performed. The duration of this pause

or rest is estimated at rather less than five-tenths of one complete cycle, so that you will at once see that the heart really rests a great deal.

This arrangement is the only one compatible with the continuance of life, that could have been devised for the rest and renovation of the heart; but though well adapted for this special case, the other organs require longer periods of repose, and are not fitted for taking their rest in snatches.

The importance of sleep is at once shown, if we consider that it occupies about a third of our lives. A man of sixty has slept away about twenty of those years. Though the precise mode in which it is brought about is still unknown, for we are still ignorant of its cause, its object is clearly, as was said long ago, "the reparation of exhausted power," for sleep is "tired Nature's sweet restorer."

No doubt the daily and nightly alternation of sleep and the waking condition is connected with the law of periodicity—of periodical recurrence—that so widely pervades all Nature. The occurrence of sleep must be connected with some condition of the nervous system which has not yet been fathomed, although one or two points are pretty fairly made out. It has often been said that the brain is, during sleep, in a state of anæmia, *i.e.*, that it contains less blood than usual. Many facts have been brought forward to prove this. In cases where a portion of the skull has been removed, the surface of the brain has been found during sleep to sink lower and to be less highly charged with blood than during the waking state. Hence it has been inferred that this diminution in its supply of blood is the cause of sleep. But while the facts are not disputed, it must be remembered that another explanation is possible, that during sleep the functions of the brain are in great part in abeyance, and that when the function of an organ is not being performed its blood supply diminishes. It is quite possible, therefore, that this anæmia or pallor of the brain may be the consequence, and not the cause, of sleep. We must confess, then, that the cause of sleep is not made out.

Admitting this, we do, however, know many of the circumstances which favour its production or retard its advance. Among these are a moderate degree of fatigue both of body and mind; "recent, but moderate, supply of food; quietude or monotonous sound; absence of anxiety, and habit." To these may be added, darkness

or a dim light; a comfortable, easy position in bed, with a proper amount of covering, so as to avoid the sensation of cold, or of too great warmth. Along with these there must also be a mental condition as nearly passive as possible. All activity of thought must be checked, and the mind must be as nearly as may be a blank.

Everyone knows how moderate fatigue, especially if brought on by exercise in the open air, produces a feeling of drowsiness and an inclination to rest. And the same may be said for most people of a moderate amount of mental fatigue; while on the other hand, excessive exhaustion of mind or body will be enough to drive sleep from the pillow. This is true of what we may call ordinary excessive exhaustion, if such an expression may be allowed. When the nervous system is, however, thoroughly worn out, as in the cruel tortures which in times gone by were inflicted on prisoners, the poor victims would actually sleep on the rack, and only be roused up by some fresh addition to their pangs. And Shakespeare drew, as he always did, a true picture when he put these words into the mouth of Henry IV.:—

How many thousand of my poorest subjects
Are at this hour asleep! O gentle sleep,
Nature's soft nurse, how have I frighted thee,
That thou no more wilt weigh my eyelids down,
And steep my senses in forgetfulness?
Why rather, sleep, liest thou in smoky cribs,
Upon uneasy pallets stretching thee,
And hush'd with buzzing night-flies to thy slumber,
Than in the perfum'd chambers of the great,
Under the canopies of costly state,
And lull'd with sounds of sweetest melody?
O thou dull god, why liest thou with the vile
In loathsome beds; and leav'st the kingly couch,
A watch-case, or a common 'larum-bell?
Wilt thou, upon the high and giddy mast,
Seal up the ship-boy's eyes, and rock his brains
In cradle of the rude imperious surge,
And in the visitation of the winds,
Who take the ruffian billows by the top,
Curling their monstrous heads, and hanging them,
With deaf'ning clamours in the slippery clouds,
That, with the hurly, death itself awakes?
Canst thou, O partial sleep! give thy repose
To the wet sea-boy in an hour so rude;
And, in the calmest and most stillest night,
With all appliances and means to boot,
Deny it to a King? Then, happy low, lie down!
Uneasy is the head that wears a crown.

In general, people get off to sleep most easily when all around them is still; but this is very much a matter of habit. The dweller in one of the great thoroughfares of our large towns, where sounds of passing vehicles catch the ear almost all the night through, can sleep without difficulty, while in the quiet country the stillness of the night is oppressive, and sleep is sought in vain. There is truth in the old story of the miller who could sleep in the sound of his mill, but who woke if it stopped. And of course the converse is also true. Those who are used to stillness at night are disturbed by the noises of the street.

Every one knows, too, how anxiety and suspense drive away sleep. The mind is active, and in a state of unrest. Painful thoughts and anticipations cannot be banished; but when the worst is known, sleep visits even the condemned prisoner.

So far sleep has been spoken of as if it were always alike, with no varieties of kind or degree. It is matter of common experience, however, that it may be very light and easily interrupted, or so deep and heavy that the sleeper is roused with difficulty. And so we have expressions in common use, such as sound and refreshing, or disturbed and broken sleep.

You must all be aware of a curious weakness common to most of us, and have no doubt been often amused at the reluctance shown by people to acknowledge that they have been asleep, as if there were a sense of humiliation felt at such a confession. Children who delight in the occasional privilege of sitting up beyond their usual bed-time are often seen with tired eyelids, which will, in spite of their efforts, get too heavy to be kept open, and yet they courageously say they are wide awake, when perhaps the next moment the poor little head droops, the limbs relax, and they are carried off in happy unconsciousness. This is not very wonderful, but it seems odd that up to life's close there should be the same unwillingness to acknowledge sleep as the victor.

It is not very rare to hear the sleeper of mature age say, "I have not been to sleep," when the nodding head, the book or work fallen from the hands, and even, perhaps, the gentle snore all bear testimony to the contrary.

Though we are so familiar with sleep, yet from its very nature it is difficult to know precisely what the changes are which actually occur, nor is it easy to guage its depth or intensity.

As we have already said, the senses one by one cease to be

active, and the will gives up its control. This means that the brain and a part of the nervous system are at rest, but only partially. Thoughts and fancies float, as it were, through the mind, unchecked by the will, and we have dreams and visions of the night. It is said by some that though, when we wake, there may be complete unconsciousness of all this, yet that even in the deepest sleep dreams are present. Many have thought they only take place as we gradually pass off into sleep, and as we are coming out of it. Though this, perhaps, may never be absolutely ascertained, it is probable that in deep sleep dreams are present, but not remembered, and that those we do recollect have taken place when sleep has been light.

Many curious instances might be given of the strange incoherent fancies that crowd on the mind when the control of the will is removed. And it is interesting to trace, as may sometimes be done, the origin of the incongruities that so frequently give to dreams their peculiar grotesqueness. The events of the day leave their impress on the mind, and any train of thought that has then occurred may have its share in the construction of a dream. Not, indeed, that dreams only reproduce the immediate past. Old stores of memory are sometimes ransacked, so that scenes and recollections of early life are blended in the most impossible fashion with those of middle or old age. It is curious to see how things that have no relation whatever to each other are interwoven into an incongruous whole, which may all the time be so vividly depicted, and may have an air of such absolute reality, that its absurdity is not felt till the dream has vanished and the sleeper awoke.

An instance of this blending of ideas—absolutely incompatible except in a dream—occurred to a well-known musician of this city quite recently. I will give it very nearly in the words he used in describing his dream to me:—" During supper, after the concert of February 26th, conversation at the table turned on the roughness of the game of football, as now practised, and various mishaps were related. During the night, I went through a great deal of the music performed at the concert, and mixed up with it the game, as discussed above, in the following fashion:—My youngest son was on a couch—on the platform I think—holding his hands over his mouth in great pain, trying to hide a very ugly wound and swollen lips, resembling those of a Hottentot. I said to him,

'What are you lying there for in the key of E flat when we are singing in C?' His answer was, 'A boy has just kicked me in E flat.' The reply seems to have been considered satisfactory, and the music proceeded."

In this instance it is evident that the grotesque mingling of ideas having no relation to each other was due to the impression left on the mind by the events of the evening, coupled probably with some difficulty on the part of the stomach in dealing with the supper taken just before bed-time.

So well known is the effect of a heavy or indigestible meal in producing dreams, and especially that distressing variety called nightmare, that if you are told of a horrible dream the usual observation is—"Oh, you had toasted cheese for supper." Cucumber, cold pastry, and various other things are held accountable for many strange visions of the night. It is said that Mrs. Radcliffe, the authoress of the Mysteries of Udolpho, and of other stories, full of the exciting, the improbable, and the horrible, used to take for supper all sorts of indigestible things, so that her mind during sleep might be filled with "phantoms of horror."

There is no unfailing recipe so far as I know for producing the opposite effect, and we cannot ensure that our dreams shall be pleasant. If this could be done, how many whose days are joyless or wretched would look on the hours of sleep as the happiest of their lives!

All sorts of stories are told as to remarkable dreams, but as a rule their accuracy is more than doubtful. Difficult problems are said to have been solved, beautiful music to have been composed in dreams, and distant events to have been revealed. If any of these things do happen it must be so rarely as to be of little practical importance. On the other hand, there is a wide-spread belief that a dream has sometimes had some real connection with distant occurrences, as the death of a friend or relative; and many people think them supernatural, as when the death of a friend has been dreamt of, and it is afterwards found to have taken place at the time of the dream. Sometimes the distant person is brought vividly before the mind, it is said—not necessarily in a sad or sorrowful mien—and by and by, intelligence has come that at this exact time his death has happened. This is a subject which would lead us too far away from our immediate topic, so that it must not be entered on. But it may be allowed even by those

disposed to be sceptical as to such matters that cases are occasionally met with depending on testimony that would be accepted in any ordinary matter of business. There is a curious and interesting condition of mind often noticeable on the approach of sleep. We will suppose that everything is favourable to its occurrence, that the mind is not actively engaged. While still awake, we may become aware of scenes depicted quite clearly before the mind's eye—of scenes apparently real—where figures move about, where voices are heard and conversation is carried on, which we see and hear without surprise. These scenes may change or disappear—to be followed, perchance, by others—sometimes in harmony with the ordinary occurrences of life, but often combining the possible and impossible in a fashion only to be found when reason ceases its control. All this may take place before sleep actually occurs, and there is the distinct consciousness that these pictures are unreal, unsubstantial apparitions. The mind may take up the position of spectator, as it were, and listen to the words spoken, may watch the actions and features of the moving pageant, without the will interposing to put an end to the scene. Should this take place, however, all this fabric of a vision vanishes, and the waking dreamer is brought back to wakefulness. But if no interruption occurs, the play, so to speak, goes on till unconscious slumber draws the curtain on the outer world.

Now, although when sleep is deep the body is still, in lighter slumbers movements of the limbs may take place without the sleeper awaking. He may turn over from one side to the other, and move his arms and legs, &c.

The late Sir Henry Holland says—"There is one condition of sleep so light, it may fitly be termed, that the person can manifestly hear questions addressed to him, and even sometimes make partial or broken reply; and it is an old trick to bring sleepers into this state by putting the hand into cold water, or producing some other sensation, not active enough to awaken, but sufficient to draw the mind from a more profound to a lighter sleep."

It is said that the Dacoits or professional thieves of India adopt a plan somewhat akin to this, and can actually steal away the mattress on which a person is sleeping. They tickle some part of his body, which moves away a little. This is followed up by another part being tickled, which likewise edges away; and the process is repeated until at last the sleeper edges himself off the

mattress altogether, and the thief walks off with it in triumph. This accomplishment is, no doubt, made all the easier by the mattress being placed on the ground, according to the custom of the country.

And here a word or two may be said about somnambulism or sleep-walking, which is most commonly a combination of dreaming and sleep-walking. Sometimes, however, the "sensorial centres" are in a state of activity, so that the muscles respond to external impressions, while the lobes of the brain—which are more immediately concerned with the functions of the mind—may be in complete repose. When this is the case, we have the purest instances of somnambulism, and the sleep-walker will perform actions impossible to him in the waking condition, as, for example, walking across chasms on narrow planks, climbing up to the roofs of houses, &c. But the accounts of these feats are as a rule very greatly exaggerated.

We must not forget, however, the purpose of sleep. It ensures rest in its highest degree, and rest is necessary for repair. All action, whether of mind or body, involves destruction, and without sleep and rest destruction would proceed so much more rapidly than repair that our powers would soon fail altogether. It is found, therefore, throughout animated creation that there are alternate periods of action and repose. It is probable that the sense of fatigue in muscles that have been exercised may be due to the waste having outrun repair. So with the sense of mental fatigue. Hence the need of sleep and rest. For it is quite certain that although the brain may to some extent be nourished and undergo repair, so to speak, during the day, its renovation takes place chiefly during sleep, when its functions are least actively performed.

When we come to apply these general teachings to actual life, we want to know how much sleep we should allow to ourselves, and how much to the young and old.

Sleep, as we have said, varies in intensity, or, as we may put it, in value. Attempts have been made to judge of this by the loudness of the noise required to wake the sleeper, and it has been concluded that in ordinary sleep at night it "increases very rapidly in depth or intensity at first, that it reaches its maximum within the first hour, and that, thereafter, it diminishes, at first rapidly, but afterwards slowly. At the end of an hour and a half

it falls to one-fourth, at the end of two hours to one-eighth of its maximum intensity, and thence onwards it diminishes with gradually diminishing decrements. This is in harmony with popular belief as to the value of the first sleep, and the superior restorative power of one hour's sleep before midnight over two after it."

Most sleep is required in babyhood and old age, and the least in adult life.

During the first few weeks of its life, an infant will sleep the greater part of the day and night. It will take food, and it ought to be the food that Nature provides for it, at intervals of two or three hours, and will soon drop off to sleep again. As time goes on, the night sleeps will become longer, and those in the day shorter. At the age of twelve months it will have a long night's sleep of ten or twelve hours, broken only once or twice for food. During the day it will sleep when taken out, and have a long sleep of two or three hours in the middle of the day. And this mid-day rest should be kept up till the child is three or four years old.

No doubt the reason of the infant sleeping so much lies in the fact that infancy is the period of the most rapid growth of brain. This rapidity of growth gradually diminishes as adult life is approached, and there is a lessened demand for sleep. In manhood, we may consider that eight hours' sleep will be sufficient to make up the loss from wear and tear. During the period of growth, however, more is required, as growth has to be provided for in addition to wear and tear.

In childhood there is great activity and constant exercise of the muscular system, and the senses are incessantly active, and those parts of the nerve centres engaged stand in need of repose.

The man who is employed in intellectual pursuits can rest his mind during the day, if he chooses, by turning to some other occupation for a time, and does not, therefore, need any increase in his amount of sleep; but another who is occupied with physical labour cannot rest, and he who, as it is said, "lives in his animal activities, cannot by any expedient rest these during wakefulness, and so has to proportion his sleep to the daily strains imposed on them."

Children, when not overworked, do not require more sleep when they begin lessons, and as a rule sleep longer during holidays than at school, "the reason of this being that the lower nerve-centres,

the exhaustion of which is the measure of sleep, are severely exercised during hours of play." After prolonged muscular effort, or watching, it is impossible to keep the eyes open—sleep will come; but intense study drives away sleep. The reason of this is that with great mental effort and toil, the circulation through the brain becomes more active, there is an increased flow of blood to it, on account of increased functional activity. Before sleep can be secured the mental excitement and the circulation through the brain must be calmed down. And this is not always easily brought about.

One important point is to give up active brain work at least an hour before going to bed. This is applicable to children engaged in lessons, and to grown-up people occupied in intellectual toil. All work of this kind should cease and be replaced by pleasant, light conversation, soothing music, some game (not too engrossing), or light reading.

The bodily comfort in bed must of course be secured. The bedroom must be efficiently ventilated, and this is a condition which is, I fear, but rarely fulfilled. There must be freedom from draughts, and a comfortable temperature. The covering must be sufficiently warm, but not too heavy. It would be a good thing if all the close, heavy cotton counterpanes of various kinds were done away with, and nothing but porous woollen coverings used.

It is scarcely necessary to warn anyone in these days against the cruel and wicked practice of frightening children with dreadful stories, which their active imaginations conjure up at night with untold additions of horror, so that terror prevents them sleeping. A child should feel safe, and there should be the sense that a protector is at hand and would come if called for.

One word may be said here as to the arrangements for lessons in schools. The special fault is that their preparation—which is of course the severest part of the child's work—has almost always to be done at night. At this time both body and mind have gone through the day's work, and need repose. But instead of rest the wearied brain has to be roused to effort, and spurred to the task of fresh acquisition. The memory, perhaps, refuses to store up the verses or the lessons that have to be repeated in the morning. The mind is often at that time unable to cope with arithmetical calculations, and the columns of figures will not add up correctly. Besides fatigue, anxiety is added, and fear of punishment, or of

loss of place in the class, and a restless, feverish condition is induced which drives sleep away, or fills the mind with disquieting dreams. If this goes on long, the general health suffers; headache is the rule rather than the exception, the appetite and digestion fail, the spirits droop, and, in short, a condition threatening most serious and, indeed, fatal brain mischief may be the result.

Education is, as we are all agreed, of immense importance. To be of proper value, however, it must be so arranged that the body shall not suffer. There must be the sound mind in the sound body, and it would seem as if the latter had scant consideration in the schemes of some of our educationists. Yet when you look on the small, weakly, ill-developed crowds pouring out of our mills, you must surely feel it important that some means should be devised to benefit the minds without at the same time further injuring such feeble and degenerate bodies. Some re-arrangement of work so that "preparation" shall not be driven to the end of the day, when it has to be done often in a crowded and noisy room, without the help or guidance of the teacher, cannot surely be difficult and is urgently needed.

It is well known that all persons do not require the same amount of sleep. With some it is more profound, and so of greater value, and goes further, so to speak, than with others, and the amount required at different ages also varies. Absolute rules cannot, perhaps, be laid down, but the following table gives what is considered as the fair average for the corresponding ages:—

At 4	years	12	hours.
7	"	11	"
9	"	10½	"
14	"	10	"
17	"	9½	"
21	"	9	"
28	"	8	"

Children are inclined as a rule, and may be allowed to sleep a little longer in winter than in summer. Much increase or much diminution of sleep in a child should always arouse attention, as it is generally an indication of illness.

As regards adults, they may generally be trusted as to the allowance they give themselves; but I feel sure that in such communities as ours, where both work and the pursuit of pleasure

are apt to be engrossing, the amount of sleep is often insufficient, and that many of the cases of over-work which come before the medical man can be cured by the addition of an hour or two more to the night's rest.

But, to revert to what has been mentioned already, what must be done if you cannot sleep? *Why* cannot you sleep? Try to find out the reason. What are the causes of sleeplessness? We have mentioned over-much mental work; then there are excessive emotions, long-continued harass and worry from any cause, as our daily work, business speculations, or perhaps the prickings of a conscience ill at ease. Each of these has to be dealt with as you can best devise. Indigestion is a sad disturber of sleep, and the last meal should be a light one. One important thing to remember and act on is that you go to bed to sleep, and not to think. Some people, instead of setting themselves to go to sleep, deliberately begin to think, to turn things over in their minds, and work themselves up into a state of mental activity and wakefulness, and then wonder how it is they "cannot get off." The remedy is in their own hands.

Some articles of diet, especially tea and coffee, are apt to cause wakefulness, and this even if taken quite early in the afternoon. Green tea has a worse character than black, and should be avoided altogether. Is the glass of spirit and water at bed-time at fault? Your health would not suffer by an experimental abstention from it, and it would be well to try. No doubt it has often happened that a moderate glass with hot water has aided in the production of sleep, by its action on the circulation of the stomach, dilating its vessels, and so drawing away blood from the brain, which, perhaps, has contained more blood than is favourable for the production of sleep. But this effect may often be obtained without the spirit, and if hot water is not relished, though some people like it, a bowl of weak beef tea, or thin gruel or arrowroot, or even oatmeal porridge, may answer the purpose, without being open to the objections that may be urged against the habitual use of spirits.

A warm bath, not too hot, sometimes acts like a charm, and turns the scale in favour of sleep.

You may have read of various artifices used to produce sleep, such as repeating some form of words, counting, watching imaginary sheep pass one by one through a gateway, and so on. Some people seem to find one or other useful, but with many more, a

condition of mind too active for sleep is brought about by the very means intended by their monotony to lead to somnolence.

It would be out of place to speak here of those extreme instances of wakefulness where actually no sleep is obtained night after night. These are cases of illness or disease where the aid of the doctor should be sought. He will perhaps have to use drugs, which in his hands may be safely used. I have not mentioned their use hitherto, and only do so now to caution you against playing with these two-edged tools. From time to time cases of death occur from their unauthorised use, and the public prints state that such and such a person has died from an overdose of chloral or opium, &c. They do not, however, state how many are injuring themselves most seriously by habitually indulging in the abuse of dangerous narcotics. The question of their use is one that should always be referred to the judgment of a medical man, who knows the dangers attending them and the caution with which they should be given.

The remarks I have made touch but lightly the subject of this lecture, but if they lead you to think more of that marvellous condition, sleep, and to have views of its nature and purpose at all clearer than you have hitherto had, my purpose in addressing you will be accomplished.

ON THINKING.

By JULIUS DRESCHFELD, M.D., F.R.C.P.

Professor of Pathology, Victoria University; and Physician, Royal Infirmary, Manchester.

FROM the title given to this lecture some of you might perhaps expect a philosophical discourse on a very obscure subject. Such, however, is not the object which the Committee of the Sanitary Association had in view; and while this title was only chosen to harmonise with the headings of the other lectures in this course of popular Health Lectures, the object in view is to give you a short exposition of some of the fundamental points in the structure and function of the nervous system—to show you how delicately framed it is, how important a part it plays in the human organism, and how essential it is for you to keep this important system in a healthy state.

The human body is, as I need scarcely remind you, a very complicated and wonderfully-constructed machine, and, like all complicated machinery, it consists of a number of separate parts, each of which has a certain definite work to do, and all of which have to work harmoniously together, if the machinery is to be kept in good working order. Thus we have parts which are concerned in the taking in of food, and in abstracting from the food substances which have to build up and nourish our body, and in elaborating them in such a way that they can be easily taken up into the system—the digestive organs. The substances so elaborated are taken up by a number of small pipes to the central organ—the heart, which also receives the blood charged with impurities from all the different parts of the body. The heart now, acting as a pump, sends the blood into the lungs; there the blood exchanges its impurities for pure air, which we breathe in—or

rather ought to breathe in—while the air charged with the impurities of the blood is breathed out. From this you will see at once the importance of pure air to our well-being, which is insisted upon by all interested in the public health. The purified blood passes back again to the heart, and is sent thence to all parts of the body to supply them with their nutrient material. The harmonious action of all these different organs—the digestive system, the heart with its blood vessels, and the lungs—is brought about by the nervous system, the action of which goes on uninterruptedly, without our being conscious of it, and without our will. Again, as a part of our machinery, we have certain organs, muscles, or pieces of flesh, which enable us to carry out the different and sometimes very delicate movements; the muscles and the movements caused by their contraction stand again under the control of the nervous system, and if that part of the nervous system which governs their action be diseased, they can no longer act—they are paralysed.

Let us take a higher function, and the all-important action of the nervous system will again appear. Let us take "speech" for an example. The mechanism of speech consists in the utterance of certain sounds, and these are produced by an apparatus similar in principle to that seen in any wind instrument. Yet this mechanism is entirely under the control of and dependent on the nervous system, and if we take the highest function, such as thinking, we find, though the mechanism of its production is not known to us, that this faculty rests in and is entirely a product of the brain.

These few examples sufficiently show you that of all parts of the body the nervous system is the most important, for it is not only the seat of the highest faculties, but it is also the governing and controlling centre of all other organs of the body.

Let us now see what this nervous system consists of. It consists of the brain, spinal cord, and nerves. These several parts, being of delicate structure, are, wherever it is possible, so placed as to be safe from injury or pressure. The brain is enclosed in a strong bony box, the skull; the spinal cord in a series of bony rings, commonly called the backbone, or spine, which are so joined as to allow the body to move in any direction without any pressure being produced on the enclosed spinal cord, and also to allow jumping, leaping, &c., without the spinal cord receiving any shock; and lastly, the nerves are, wherever it is possible, placed deeply and in protected situations.

If we look at the brain (see Fig. 1), we find it to consist of two large masses—the large brain (cerebrum), which fills the greater part of the bony box, and the small brain (cerebellum), which is below and behind the large brain. Each of these consist of two symmetrical halves. The surface of the large brain consists of a number, of hills and dales, the so-called convolutions, and the interior of the brain contains a series of important structures; the large and smaller brain are joined by thick bands, called the crura. A mass of fibres from the large and small brain pass through a hole at the back of the skull and enter the bony canal of the spine, where they constitute the spinal cord. The under surface of the brain, besides showing the above

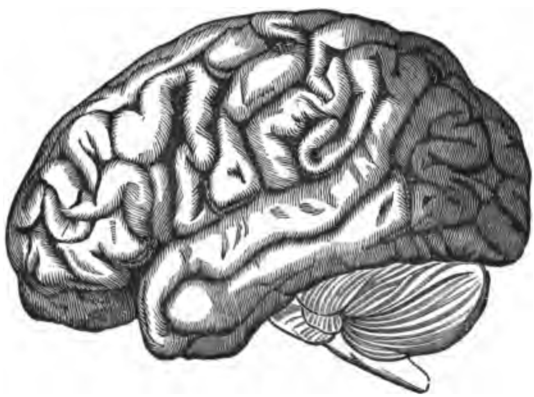


FIG. 1.—The Brain.

juncture, also shows a number of fine white threads; these are nerves for the head and face, some of which go to the different organs of our special senses, and form the connecting link between the brain and these organs. From the spinal cord pass out on each side, through small holes in the backbone, white threadlike fibres—nerves; and as they pass out we distinguish two kinds—motor and sensory. These join and pass on as white fibres, becoming smaller and smaller, into the different parts of the body, and though the nerve threads seem to join, they are really separate, and have different functions.

Besides this system, which we call the cerebro-spinal system, we have another nervous system—the sympathetic system. This

consists of a series of small bodies—the ganglia—lying on each side of the spinal column. The ganglia are connected by fine nerve cords, and the whole sympathetic system stands in close connection, by nerve threads, with the brain, the spinal cord, and the nerves.

If we look at the whole nervous system from another point of view, we may divide it in two portions—the grey matter and the white matter. The white matter is seen to make up the nerves, both sensory and motor, and a great part of the interior of the brain, and the outer part of the spinal cord, and it may be likened to telegraph wires—for we shall see that impressions are simply conducted along it. The grey matter is found in the ganglia, the inner part of the spinal cord, the whole of the outer part and in some of the inner parts of the brain, and it may be likened to telegraph offices, with their batteries, the grey matter in the brain being, so to say, the central telegraph office, the grey matter in the spinal cord the local telegraph offices.

If we examine the white and grey matter with the help of a powerful magnifying glass, we find the comparison we have just made comes out still better. If we take a nerve, which we have just seen belongs to the white matter, and examine it (see Fig. 2), we

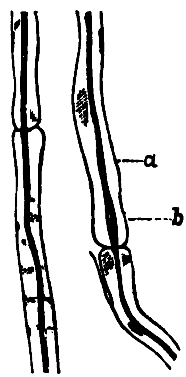


FIG. 2.—Two Nerve Fibres, showing the nodes or constrictions of Ranvier and the axis cylinder. The medullary sheath has been dissolved away. The deeply-stained oblong nuclei indicate the nerve corpuscles within the neurilemma.

find it consists of a number of very fine threads, or ultimate fibres, and each fibre is made up of two parts : a sheath—the so-called

medullary sheath—(*a*) consisting of fatty matter and a central rod; (*b*) the axis cylinder. The sheath acts simply as an insulator, and prevents the message which is passed up or down the axis cylinder from being in any way interfered with.

If we examine the grey matter with the help of a magnifying glass, we find it (see Fig. 3) to consist of a number of small bags (the ganglion cells), with irregular outlines, and having one or more small twigs proceeding from it, while in its interior it has a number

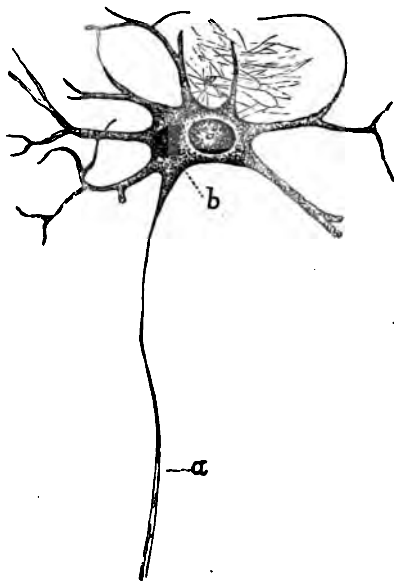


FIG. 3.—An Isolated Ganglion Cell of the Anterior Horn of the Human Cord. *a*, Axis cylinder process; *b*, pigment. The branched processes of the ganglion cell break up into the fine nerve network shown in the upper part of the figure.

of small granules and a mass of larger granules, closely packed, and called the nucleus. The ganglion cells are connected either directly or indirectly with the axis cylinder of the nerves.

The nerve terminations in our special sense organs, such as the eye, the ear, the nose, are of a more complicated structure, and it is impossible for me within the scope of this lecture to describe these to you.

I have spoken of sensory and motor nerves, and I must tell you at once that a sensory nerve conveys an impression from the periphery, we will say the skin, to a ganglion cell—say in the cord—whilst a motor nerve carries the impulse from a ganglion cell to the muscle with which it is connected.

After this brief and incomplete description of the structure of the nervous system, we will now direct our attention to the action of the nervous system. Let us take a few simple illustrations. Suppose some one asks me to move my foot. I do so instantly, and this is a simple voluntary action, and yet it involves a series of processes. An impression is made on the terminal branches of the nerve of hearing by the sounds uttered; this impression travels along a certain path in the brain to be elaborated there into a distinct perception, and then into an idea; then a message is sent off by groups of ganglion cells in a definite spot in my brain to another group of ganglion cells in the spinal cord, and from these a further impulse is sent through the motor nerves to certain groups of muscles in my leg and foot, and, as the result, we have certain movements in the direction indicated by the will.

Now, let us vary this illustration somewhat. A person treads on my foot. I at once, without will, move my foot away. This is produced by a somewhat different mechanism, namely, when the foot is touched, a sensory nerve is irritated; this carries the message to the telegraph office (group of ganglion cells) in the spinal cord; there the message is sent round to another group of ganglion cells, which are attached to the motor nerves. These motor nerves are thus irritated, and as the result we have the contraction of the muscles supplied by them, and the result is a movement of the foot. This is called *reflex action*: it takes place without the brain being in any way communicated with; it takes place without our volition; and this is important, for it enables us to ward off injuries while our brain is occupied with other things.

A simple experiment will illustrate this to you better than any description I can give. Here is a frog which is decapitated; on touching one of its feet with a drop of acetic acid, you can see that it at once takes the other foot and wipes away the irritating fluid; the brain is therefore not wanted for this nervous action, which has its centre in the spinal cord. That the centre is in the spinal cord I can easily prove, for if I destroy the spinal cord and repeat the experiment, no reflex action takes place. In disease we often have an opportunity of seeing that a very similar reflex action

exists in man; it happens, unfortunately not rarely, that by a fall from a height the spinal column becomes fractured and the spinal cord severely damaged; in such a case we find the patient completely paralysed; he is not able to move on his own free will either foot; on, however, irritating the foot by tickling the sole of the foot, the patient will involuntarily draw up the leg.

Reflex action plays a most important part in the human economy, and the most important functions are performed by its aid. To give only one instance: You all know that the temperature or the body heat of man in health is the same, whatever the surrounding temperature may be, and it is essential to our well-being that this temperature of the body should remain the same under all circumstances, for the normal processes cannot be carried on if it be much lower or much higher. Now, if we are surrounded by very cold air, then our temperature, according to an unalterable law of physics, would eventually be that of the surrounding medium; but see what happens: the cold air, acting as a stimulus or irritant, affects the sensory nerves of our skin; this stimulus is carried along these sensory nerves to a centre; an impression is there made, and, as a consequence, all the small blood vessels (arteries) which supply the skin with blood contract—they become narrower. As now less blood circulates near the surface of the body, there is less loss of heat from the surface o the body, and the cooling of our body surface is thus prevented. If, on the other hand, the surrounding air be very hot, a stimulus of a different kind is applied to the sensory nerves of the skin, another reflex act takes place, and, as a result, we have this time a widening of the small arteries of the skin; more blood flows now through them, and more heat is absorbed from the surface of the body, and the overheating by the surrounding air thus prevented.

In a former lecture given in the series of Health Lectures, I have dwelt more fully on this self-regulating apparatus, which enables us to adapt ourselves to the different climates, and which, when in proper order, prevents us often from taking cold. I merely wish now to refer to it as an example of reflex action, without pursuing this subject any further. I might give you many more instances, for most of our functions, such as the proper propulsion of food, and many others, are merely instances of reflex actions.

But we will now leave the reflex actions, which have their governing centres in the spinal cord and in the medulla, and consider the functions of the brain.

The brain is the seat of all psychical processes, and it contains the higher centres, such as preside over volition and thought.

We have already seen that there is the small brain (cerebellum), and the large brain (cerebrum).

The functions of the cerebellum have been studied in animals by removing smaller or larger portions, and it has been found as the result that the animal becomes sullen, its movements become irregular; and when the whole has been removed, the power of carrying out more complicated muscular movements, such as springing, walking, standing, and flying, is lost. In man we are enabled to study the function of the cerebellum in cases of disease of the cerebellum; and we notice here chiefly a staggering gait, and tendency to fall either to one side or to the other. Besides disease, certain other agents affect the cerebellum more particularly, as for instance, alcohol—the staggering and reeling of a drunken person are due to the effect of alcohol on the cerebellum. The outcome of these observations is that, amongst other less defined functions, the chief office of the cerebellum is to act as the centre for co-ordinating and balancing our muscular movements. If we now consider the large brain (cerebrum), we find that it has certain important structures in its interior, the functions of which are as yet not sufficiently made out, and that it is covered by a mantle of grey matter, the convolutions or cortex.

It was thought till recently that the brain, being the organ through "which the mind of man operates, had altogether superior functions to any other part of the nervous system, operating as a whole, directing, controlling, and otherwise influencing the lower centres." Experiments on animals and observations on man, when by disease parts of the brain are affected, have, however, shown that the surface of the brain, the cortex, may again be mapped out into certain regions, which act as the chief or head centres for movement, sensation, and the higher psychic functions. Though the convolutions of the brain, when first looked at, show great irregularity in their outline, and seem to run in very tortuous course, yet we are able to divide them into certain groups. Those which are situated anteriorly are called the frontal; those which are situated posteriorly, the occipital; those between these two sets, the parietal convolutions; whilst at the base we have the temporal convolutions.

Now, experiments on animals have shown that when the brain is laid bare, and the surface of one half of the brain is slightly

irritated by an electric stimulus, the irritation of certain spots is followed by certain movements in the opposite side of the body, and it has been found that irritation of the same spot is always followed by the same movements. On the other hand, if the spot which, when irritated, gave rise to certain movements is destroyed or cut away, then these same movements can no longer be carried out at the animal's will—in fact, there is paralysis of these muscles.

The accompanying cut (Fig 4) shows the brain of a monkey, and the numbers mark the area of the surface of the brain, which,

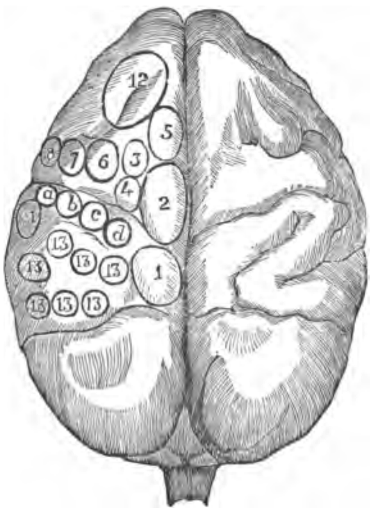
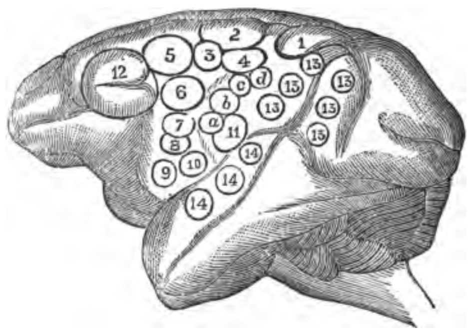


FIG. 4.—Diagram of the Brain of a Monkey, seen from above, with Localised and Numbered Areas. The stimulation of each of them is followed by the results stated in the text under the corresponding numbers.

when irritated, cause the animal to perform certain movements. The experiments were carried out by Professor Ferrier. This area is called the "motor area."

Thus irritation of the spot marked 1 produced a movement of the hind limb as in walking; of 2, more complex movements of the hind limb; of 7 and 8, movements of the upper and lower lip; of 9, opening of the mouth and protrusion of the tongue, and so on. Irritation of any other spot of the brain outside the area marked

with figures produced no movements. From such experiments Ferrier and others concluded that these separate regions were the centres for certain movements, and observations on man have fully borne out the correctness of this view. A very common disease in men is apoplexy, and this consists in hæmorrhage taking place in some part of the brain, and it has been found that when hæmorrhage takes place in a region of the surface of the brain, corresponding to the "motor" area mapped out in the above cut, paralysis of the limbs opposite results, that is to say, the centre for particular movements is destroyed; hence these movements can no longer be called for at will. You will now see the correctness of the statement I made at the commencement of this lecture, when I told you that when I voluntarily move my foot a message is sent from



Side View of the Brain of a Monkey, showing Localised Area.

the ganglion cells in a definite spot of my brain to other ganglion cells in the spinal cord. But we have a further proof. If the group of ganglion cells which correspond to the motor centre are destroyed by disease, we are able to trace a certain degeneration from these ganglion cells along a definite tract through the brain medulla and down the spinal cord. That is the path of nerve-fibres, along which the message received from the motor centre would travel if the centre be active, but now, the centre being destroyed, the nerve-fibres along this path waste, and we can thus actually follow out their course.

Observations on men have also shown that disease of the brain outside the motor area, and its path through the brain, are not

associated with any disturbance of movement; hence we conclude that this area, and this area alone, is the governing centre for movements. Other centres have also been made out on the surface of the brain, such, amongst others, as a centre for vision, a centre for hearing, and a centre for speech. The centre for speech is the best defined region, and one which has been known for many years. It is situated in the left side of the brain only, and not in the right, and is placed close to the centre which governs the movements of the face, and not far off the centre for hearing. Disease of this region of the brain has shown us that the mental mechanism of speech is of a very complex nature. Thus, in one set of cases, the patient, though intellectually sound, is unable to communicate his thought either by words or by writing; or, as in a case given by Dr. Ross, in his book on nervous diseases, he is unable to speak, but can express his wants in writing. In other cases the memory of words is defective. Thus in a patient who was under my care, and where, after death, the speech centre was found diseased, it was noted that, though he could not speak, he was able to repeat any word that was spoken to him, and though he could not write he was able to read and understand what he read. In other cases, again, the memory for certain things or parts of speech is defective only. Thus in one case quoted by Dr. Broadbent, of London, the patient could give long answers fluently so long as the phrase did not contain a noun. In a still more remarkable disorder of speech, the patient may speak fluently, write correctly, but is unable to read a single letter of what he has written. This by no means exhausts the different forms of speech affection when the centre is diseased, but the examples given may suffice.

Speech being the frame-work of thought, for articulate speech is the outward expression of the internal process of thinking, we have in this very brief and incomplete analysis of the nervous system reached a point beyond which neither the scalpel nor the microscope will be of any avail, and to penetrate further into this subject and to speak to you of ideas, of emotions, and of the highest psychical problem, is beyond the scope and purpose of this lecture.

I have said enough to show you the complex and delicate structure of the nervous system and the important part it plays in our functions, etc. Need I tell you that it is necessary for our well-being to keep that system in a healthy state? That such a deli-

cately-constructed apparatus is easily affected by various agents you may readily understand, and of the various injurious agents there is particularly one which I am bound to mention to you, and that one is alcohol. I have already alluded to the effect of alcohol on the brain, and in the many acts of crime committed whilst in a state of drunkenness you have an instance of a temporary paralysis of the highest brain functions. More lamentable still are the effects of a long-continued abuse of alcohol—the so-called chronic alcoholism which produces dementia and other forms of brain disease, from which a large contingent of our asylum patients suffer. Equally injurious are the insalutary conditions under which so many in this country live, and these, to my mind, have to answer for most, if not all, the evils which are attributed to over-pressure from brain-work. If we want to achieve intellectual progress, we must exercise our brain just as we exercise our muscles to make them strong and vigorous, but let us never forget the old and wise saying—"a healthy mind in a healthy body."

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